GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. ______

Project No. A-3312 DATE 9/2/82

Project Director: Jim Burson ~~School~~/Lab EDL/SHS

Sponsor: Iowa Power

Type Agreement: Purchase Order No. 41078 dated 8/10/82

Award Period: From 8/1/82 To 11/1/82 (Performance) 11/1/82 (Reports)

Sponsor Amount: $9,900 Contracted through:

Cost Sharing: ______ GTRI/~~GIT~~

Title: Industrial Hygiene Survey

ADMINISTRATIVE DATA

OCA Contact Faith G. Costello x4820

1) Sponsor Technical Contact:

Mr. Lynn Wallis
Safety Director
Iowa Power
P.O. Box 657
823 Walnut Street
Des Moines, Iowa 50303
PH: (515) 281-2900

2) Sponsor Admin/Contractual Matters:

W.M. Green
Iowa Power
P.O. Box 657
823 Walnut Street
Des Moines, Iowa 50303
PH: (515) 281-2900

Defense Priority Rating: n/a

Security Classification: n/a

RESTRICTIONS

See Attached n/a Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with n/a

COMMENTS:

COPIES TO:

Administrative Coordinator
Research Property Management
Accounting
Procurement/EES Supply Services
Research Security Services
~~Reports Coordinator~~ (OCA)
Legal Services (OCA)
Library
EES Public Relations (2)
Computer Input
Project File
Other ______

FORM OCA 4:781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 12/13/82

Project Title: Industrial Hygiene Survey

Project No: A-3312

Project Director: Jim Burson

Sponsor: Iowa Power

Effective Termination Date: 11/1/82

Clearance of Accounting Charges: 11/1/82

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice ~~and Closing Documents~~
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

Assigned to: EDL/SHS (School/Laboratory)

COPIES TO:

Administrative Coordinator
Research Property Management
Accounting
Procurement/EES Supply Services
Research Security Services
Reports Coordinator (OCA)
Legal Services (OCA)
Library
EES Public Relations (2)
Computer Input
Project File
Other Project Director

FORM OCA 10:781

INDUSTRIAL HYGIENE SURVEY
at
IOWA POWER AND LIGHT COMPANY
Des Moines Power Station
Des Moines, Iowa

October 12, 1982

SUBMITTED BY:

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety and Health Division
Atlanta, Georgia

Project No. A-3312

PART A

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

Iowa Power and Light Company retained the Georgia Tech Engineering Experiment Station to conduct an Industrial Hygiene Survey of it's Des Moines Power Station. The purpose of the audit was twofold: (1) determine employee exposure to several potentailly harmful chemical and physical agents identified during a previous industrial hygiene audit and subsequent surveys; and, (2) measure the effectiveness of certain engineering controls and/or work practices which have been implemented to reduce employee exposure to harmful substances or agents.

During the course of the survey, 49 total samples were collected for some eleven different substances or agents; 42 samples to determine personal exposure to substances and 7 area or wipe samples to determine workplace concentrations of specific contaminants. The survey included the collection and analysis of samples for asbestos, noise, nitrogen dioxide, carbon monoxide, total nuisance dust, arsenic, iron, zinc, total respirable dust, crystalline silica, and polychlorinated biphenyls.

This report presents the results of the industrial hygiene survey, a discussion of the findings, and five recommendations based on the results of this survey. There has been a general and consistent improvement in both occupatioanl health awareness and the implementation of engineering controls and/or work procedures to eliminate or control employee exposure to potentially harmful substances or agents. Many of the recommendations presented address conditons or procedures which have previously been established, but which now need additional education of employees and emphasis by management.

II. INTRODUCTION

Iowa Power and Light Company retained the Georgia Tech Research Institute to conduct an industrial hygiene survey of its Des Moines Power Station (DPS) located in Des Moines, Iowa. The purpose of the survey was to monitor employee exposure to selected chemical and physical agents which are encountered by employees at DPS during performance of their assigned duties. The survey was conducted on August 2 and 3, 1982 by Mr. James L. Burson of Georgia Tech. Mr. Lynn Wallis and Ms. Robin Fortney of Iowa Power and Light Company assisted in conduct of the survey. The survey included sampling for total nuisance dust, total respirable dust (coal dust), crystalline silica, asbestos, carbon monoxide, nitrogen dioxide, and noise. In addition, bulk and wipe samples were taken at selected locations for analysis to identify and quantify materials suspected of containing either asbestos or polychlorinated biphenyls.

The following report includes a discussion of the sampling and analytical results and recommendations based on those results in conjunction with a survey of the facilities and observations of work practices and procedures. Noise exposure measurements are compiled in Appendix A. Results of air sampling are in Appendix B. Analysis of the bulk and wipe samples are included in Appendix C. Appendix D summarizes the sampling and analytical methods employed for this project. A brief discussion of toxicological considerations of the various substances monitored is included in Appendix E.

Weather during the two-day survey at Des Moines Power Station was mostly clear and hot. There was one brief shower during the afternoon of August 3, 1982. Temperatures were in the high 80s and low 90s. On August 2, 1982 DPS Unit 6/10 came on-line at 6:44 AM and Unit 7/11 came on-line at 8:45 AM. At 11:15 AM Unit 6/10 load was 40 MW while Unit 7/11 load was 45 MW. On August 3, 1982 DPS Unit 7/11 came on-line at 6:39 AM. Unit 6/10 came on-line at 10:58 AM. At 2:00 PM the load for Unit 7/11 was 94 MW while the load for Unit 6/10 was 66 MW.

The function of the Des Moines Power Station is currently undergoing a change from a station that supplies power to meet the daily power consumption of the environs to a station that supplies power to meet peak demands and provide power as a backup to other power generating units. This change has resulted in a reduction in manpower requirements for the station and a change in many of the duties performed by the employees. This industrial survey, then, is in many ways an initial survey of DPS functioning in its new capacity.

III. DISCUSSION AND RECOMMENDATIONS

A. Noise

Eighteen employees were monitored to determine their exposure to noise as they moved through numerous noise environments within the DPS facilities during their work shift. The noise dosimeters worn by the employees measured exposure to continuous A-weighted noise and could be used to compare their exposures to the 85 dBA "action level" and/or the 90 dBA "permissible exposure limit".

Before discussing the noise survey results, the OSHA standard will be reviewed. Recent revisions to the existing OSHA noise standard (1910.95) established an "action level" of 85 dBA. Briefly, if workers are exposed at or above the "action level", as an 8-hour time-weighted average (TWA), employers must now provide hearing protection and institute exposure monitoring, audiometric testing, and training.

The new amendment to the OSHA Noise standard actually requires that two noise level exposures be determined. One is an "action level" of 85 dBA and the other is a 90 dBA permissible exposure level. Both of these levels are time-weighted averages over an eight-hour work shift. However, the ranges of noise levels used to make the two determinations are different. For the "action level" of 85 dBA, all noise impulses between 80 and 130 dBA are included in the calculation. For the 90 dBA permissible exposure level, only those noise impulses between 90 and 130 dBA are included in the calculation. Consequently, the employee exposure results determined by the "action level" measurement criteria should be a higher value than the employee exposure results determined by the 90 dBA permissible exposure level criteria. This is because of the fact that any readings between 80 and 89 are included in the "action level" calculation but the readings would simply represent zero noise levels when calculating the 90 dBA permissible exposure level and would therefore lower the average value.

Major hearing loss studies show 85 dBA as the level where the risk of hearing impairment becomes fairly significant. While exposures to 80 dBA indicate a 0 to 5% risk, exposures at 85 dBA indicate a 10 to 15% risk of hearing impairment. At 90 dBA, this risk jumps to 21 to 29%.

The amendment set a date of February 22, 1982, for all employers to have completed initial monitoring to determine if workers are exposed to TWA noise levels at or above 85 dBA. Actions are required of an employer, depending upon the results of noise monitoring, as follows.

(1) If the 8-hour, TWA exposures are below 85 dBA no action is required.

(2) If the 8-hour, TWA exposures are at or above 85 dBA the employer is required to: provide hearing protection (use is optional unless significant threshold shifts in hearing are measured); provide initial fitting of protectors and employee training; provide annual audiometric testing for all potentially exposed employees; and complete baseline audiograms.

(3) If the 8-hour, TWA exposures are at or above 90 dBA the employer is required to: determine and implement feasibile engineering and/or administrative controls; ensure that hearing protection is worn; provide initial fitting of protectors, train employees in use and ensure that protectors reduce exposures to below 90 dBA; provide annual audiometric testing for all potentially exposed employees; retain records of monitoring and audiograms for each worker for the duration of employment; and ensure that the baseline audiograms are completed.

All 18 of the noise exposure measurements were used to determine employee exposure in relation to the IOSH action level of 85 dBA for eight hours. In addition, 8 of these measurements were used to determine compliance with the IOSH permissible exposure limit (PEL) of 90 dBA for eight hours. Of the 18 noise exposure measurements made, 10 of 18 (55%) exceeded the 85 dBA action level. Those employees whose noise exposures exceeded the 85 dBA action level included all job titles monitored. Exposures appeared to be a function of the employees' specific activity and location of that activity in the plant more than anything else. This also appears to be the case when comparing the exposures made during this survey with those made during previous surveys.

Table I presents a frequency distribution of the 18 noise dosimetry measurements made with respect to the 85 dBA action level.

TABLE I

Equivalent Exposure Range (dBA)	Number of Samples	% of Samples
>85	10	55
>80 but <85	3	17
>75 but <80	3	17
>70 but <75	2	11
<70	0	0
TOTAL	18	100

Eight measurements were made to determine employee exposure in terms of compliance with the 90 dBA IOSH PEL. Three of the eight measurements were at or above this limit. Noise exposure measurements made during this survey are compiled in Appendix A.

Iowa Power and Light Company has developed and implemented a comprehensive hearing conservation program to protect employees from potentially harmful exposures to noise. The plan requires employees to wear hearing protection at the power stations. Although most employees were observed wearing hearing protection, several were noted not wearing the required hearing protection.

> Recommendation #1 The wearing of hearing protection by employees working in high noise areas should be strictly enforced.

B. Total Nuisance Dust

Total dust exposures were determined for eleven employees during the survey. The concentrations of total dust ranged from 1.14 to 9.31

milligrams per cubic meter of air (mg/m^3). All samples were below the IOSH PEL of 15 mg/m^3 for total dust, or the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 10 mg/m^3, determined as an 8-hour time-weighted average (TWA).

Four of the samples (samples T-2, T-5, T-8, and T-11) collected were analyzed for metal content. The analysis indicated the concentrations listed in Table B-3 of Appendix B. All exposures for the employees to iron, arsenic, and zinc in the dust were below the IOSH permissible exposure limits.

C. Total Respirable Dust (Coal Dust)

Five employees were monitored for their exposure to total respirable dust (coal dust). In all instances, these samples were collected for employees performing coal handling duties or repairing equipment which processes coal. In one instance (Sample #R-4), the sampling device was tampered with by the employee and the sample voided. The three coal handling employees received exposures below the IOSH PEL for coal dust of 2.4 mg/m^3, determined as an 8-hour TWA. The exposures for the coal handling employees ranged from 0.47 to 1.14 mg/m^3. A mechanic involved in the repair of a coal pulverizer received an exposure in excess of the IOSH PEL for coal dust. This sample (Sample #R-2) indicatd an exposure of 4.33 mg/m^3 compared to the IOSH PEL of 2.4 mg/m^3 for coal dust.

Two of the respirable dust samples (Samples No. R-3 and R-2) were analyzed for crystalline silica (quartz). The samples contained 2.3 %

quartz (Sample R-3) and 2.4% quartz (Sample R-2). The silica content is somewhat higher than samples analyzed in previous surveys and may be accounted for by the increased amounts of dirt, rock, etc. exposed as the coal pile is lowered. Employee exposure to free silica for Sample R-2 was almost twice the calculated PEL of 2.4 mg/m^3. Silica exposure for the second sample analyzed (Sample R-3) was below the calculated PEL.

D. Asbestos

Two area air samples and one bulk sample were collected for asbestos at DPS. Sample results are compiled in Appendix B. The bulk sample was taken from turbine/generator #1 which is no longer in use. The insulation sample showed an asbestos content of 42% chrysotile. Pieces of the insulation were loose and broken and had fallen to the floor.

In addition, numerous pieces of insulation were observed in the gratings and on floors through the facility. Particularly large amounts were seen on the floor at #6 condenser and #7 condenser. Although samples from these locations were not analyzed for asbestos content, results of samples from previous surveys would indicate that this insulation contains asbestos ranging from 40 to 60 percent. Area air samples taken near the #6 condenser and #7 condenser did not indicate a concentration of airborne asbestos fibers in excess of the IOSH PEL of 2 fibers*/cc or the "action level" of 0.1 fibers*/cc. Work involving removal of asbestos insulation and/or logging was not performed at DPS during this survey and therefore was not monitored.

*greater than 5 micrometers in length

Recommendation #2 Housekeeping practices at DPS should be improved to include prompt removal of insulation materials and settled dust to reduce the potential for asbestos exposure. The dust should be removed using a high efficiency particulate absolute (HEPA) filtered vacuum to minimize the re-entrainment of asbestos-containing dust.

Recommendation #3 Consideration should be given to a number of alternative methods to either remove deteriorated lagging and insulation or secure it so that it will not separate from its surface and fall through the facility.

Recommendation #4 Because of the deteriorated state of asbestos-containing lagging and insulation at DPS, employees should be cautioned concerning potential exposures to asbestos and trained to identify and correct insulation or lagging problems which would contribute to their exposure to asbestos.

E. Miscellaneous

1. Combustion Gases - Measurements were made to determine the concentration of combustion gases near the burners on both boilers operating during the survey. Results are compiled in Appendix B. Nitrogen dioxide was not detected at either location. Carbon monoxide concentrations were measured at 5.0 ppm.

2. Polychlorinated Biphenyls - During the survey a small quantity of oil was observed on the casing of a power transformer and puddled below another transformer. Wipe samples were taken at these two areas and analyzed for polychlorinated biphenyls (PCBs). The wipe sample from #62 Power Station indicated a PCB concentration of 2.5 micrograms. The wipe sample from #71 Power Station indicated a PCB

concentration of 14.0 micrograms. Both wipes contained PCB arochlor number 1262.

<u>Recommendation #5</u> Equipment containing PCBs should be marked as provided for in applicable EPA regulations. These areas should be frequently observed and leaks promptly repaired and cleaned.

This Report Prepared By:

James L. Burson, CIH
Occupational Safety and Health
Consultation Program

APPENDICES

APPENDIX A

Noise Exposure Measurements

Table A-1

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company: IOWA POWER & LIGHT CO.
Des Moines Power Station (DPS)

Date: 8/2/82

Test by: J. BURSON

Dosimeter Model No.: DuPont 376-X

Operating Conditions: Units 6/10 & 7/11 Operating

Calibrator Model No.: DuPont C-114

S/N:

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
		Dick Grandstaff	1533			
9690	2165	Mechanic (Hanging Board in Storeroom)	0740	473	84.2	--
		Bracy Skidmore	1535			
9693	4284	Mechanic	0746	469	76.3	--
		Bob Harrison	1532			
9710	4281	Electrician (Water Chemicals, Vapors)	0747	465	71.8	--
		Paul Chopard	1532			
9700	4513	Mechanic (Mills)	0749	453	89.3	--
		Lester Dawson	1535			
9711	1774	(Breaker House, Mowing Grass)	0801	454	85.0	--

Table A-2

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company IOWA POWER & LIGHT CO.
Des Moines Power Station (DPS)

Date 8/2/82 Test by J. BURSON

Dosimeter Model No. Metrosonic dB 301 S/N N/A

Operating Conditions Units 6/10 & 7/11 Operating

Calibrator Model No. S/N

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period Stop/ Start	Exposure Period Total Time (min.)	Equivalent Sound Level (8 hr. - TWA) Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA) Permissible Exp. Limit (dBA)
2890	--	Bob Sowles Equipment Operator	1440 0643	479	92.8	92.2
2750	--	Al Belinsky Equipment Operator	1439 0649	472	91.5	90.8
2891	--	Bob Shanks Equipment Operator	1440 0709	353	89.2	88.2
2885	--	Brian Tindall Roving Control Mechanic	1548 0751	478	79.1	75.2
2751	--	Jim Graves Fuel Handler, Cat Operator	1548 0756	472	84.9	76.7

Table A-3

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company IOWA POWER & LIGHT COMPANY Date 8/3/82 Test by J. BURSON

Des Moines Power Station (DPS) Dosimeter Model No. DuPont 376-X

Operating Conditions Units 6/10 & 7/11 Operating Calibrator Model No. DuPont C-114 S/N

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
9690	2165	Bob Sowles Equipment Operator	1446 0633	493	92.6	--
9710	4281	Al Belinsky Equipment Operator	1440 0657	463	87.5	--
9700	4513	Bob Shanks Equipment Operator	1443 0703	460	91.2	--
9693	4284	Paul Chopard Mechanic	1529 0742	467	84.4	--
9711	1774	Dick Grandstaff Mechanic	1541 0749	472	73.4	--

Table A-4

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company IOWA POWER & LIGHTS COMPANY — Date 8/3/82 — Test by J. BURSON

Des Moines Power Station (DPS) — Dosimeter Model No. Metrosonic dB-301

Operating Conditions Units 6/10 & 7/11 Operating — Calibrator Model No. ______ — S/N ______

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
		Jim Graves	1545			
2891	--	Fuel Handler, Cat Operator	0747	478	85.4	81.8
		Tom Bartram	1545			
2750	--	Fuel Handler, Breaker House	0721	499	77.7	69.2
		Jim Cline	1525			
2890	--	Plant Attendant	0653	513	89.8	89.2

```
   GEORGIA  TECH.
  SAFETY + HEALTH
 ATLANTA, GA 30332
   (404) 894-3806

DB652 V5.7S S/N 1439
SOUND SURVEY  SYSTEM

DB-301/36   S/N 2750
BASELINE        60 DB
DYNAMIC RANGE   64 DB
SAMPLE RATE     4/SEC
STANDBY =    00:00:57
LOGGING =    08:19:08
SAMPLES =      119793
INTERRUPTS =        2
SITE  DPS
DATE  8/3/82
USER  Tom Bartram

SAMPLE  DISTRIBUTION
    (1 DB BY 1%)

      5%  10%  15%
SPL----+----+----+---
 60**
   *
   *
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 65*
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 70*****
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 75*****
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 80*****
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 85***
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 90*
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 95+
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100.
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105.
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110
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115.
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   .
120

SPL----+----+----+-
      5%  10%  15

EXCEEDANCE LEVELS

L( 0.00) = 118 DB
L( 0.10) = 100 DB
L( 1.00) =  94 DB
L( 2.00) =  91 DB
L(10.00) =  85 DB
L(20.00) =  82 DB
L(30.00) =  80 DB
L(33.33) =  80 DB
L(40.00) =  78 DB
L(50.00) =  77 DB
L(60.00) =  75 DB
L(66.67) =  73 DB
L(90.00) =  67 DB
L(99.00) =  60 DB

  COMPUTATIONS

L E Q =  83.0 DB
LOSHA =  80.0 DB
LOSHA(80) =  77.7
LOSHA(85) =  74.2
LOSHA(90) =  69.2

IMI METROSONICS,IN
```

GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

DB652 V5.7S S/N 1439
SOUND SURVEY SYSTEM

DB-301/36 S/N 2750
BASELINE 60 DB
DYNAMIC RANGE 64 DB
SAMPLE RATE 4/SEC
STANDBY = 00:05:15
LOGGING = 07:51:37
SAMPLES = 113191
INTERRUPTS = 1
SITE DPS
DATE 8/2/82
USER Al Belinsky

SAMPLE DISTRIBUTION
(1 DB BY 1%)

```
      5%   10%   15%
SPL----+-----+-----+--
 60.
   .
   .
   .
   .
 65.
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   .
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   +
 70*
   **
   ***
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 75*****
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 80**
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 85**
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 90***
   ***
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 95******
   *****
   ****
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100*
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   *
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105+
   +
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110.
   .
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115.
   .
   .


120

SPL----+-----+-----+--
      5%   10%   15%
```

EXCEEDANCE LEVELS

L(0.00)	=	117 DB
L(0.10)	=	111 DB
L(1.00)	=	105 DB
L(2.00)	=	103 DB
L(10.00)	=	98 DB
L(20.00)	=	95 DB
L(30.00)	=	94 DB
L(33.33)	=	93 DB
L(40.00)	=	91 DB
L(50.00)	=	87 DB
L(60.00)	=	83 DB
L(66.67)	=	79 DB
L(90.00)	=	73 DB
L(99.00)	=	70 DB

COMPUTATIONS

L E Q = 94.4 DB
LOSHA = 91.8 DB
LOSHA(80) = 91.5
LOSHA(85) = 91.3
LOSHA(90) = 90.8

END METROSONICS, IN

GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
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DA652 V5.7S S/N 1439
SOUND SURVEY SYSTEM

DU-301/36 S/N 2890
BASELINE 60 DB
DYNAMIC RANGE 64 DB
SAMPLE RATE 4/SEC
STANDBY = 00:25:32
LOGGING = 08:32:46
SAMPLES = 123064
INTERRUPTS = 2
SITE DPS
DATE 8/3/82
USER Jim Cline

SAMPLE DISTRIBUTION
(1 DB BY 1%)

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       5%   10%   15%
SPL----+-----+-----+--
 60+
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   .
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 65.
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   .
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 70+
   *
   ****
   ******
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 75*********
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 80***
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 85*
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 90*
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 95***
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100*
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105.
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   .
   .
110.
   .
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   .
   .
115

120

SPL----+-----+-----+
       5%   10%   15
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EXCEEDANCE LEVELS

L(0.00) = 114 DB
L(0.10) = 107 DB
L(1.00) = 102 DB
L(2.00) = 101 DB
L(10.00) = 98 DB
L(20.00) = 96 DB
L(30.00) = 92 DB
L(33.33) = 90 DB
L(40.00) = 85 DB
L(50.00) = 80 DB
L(60.00) = 77 DB
L(66.67) = 76 DB
L(90.00) = 73 DB
L(99.00) = 65 DB

COMPUTATIONS

L E Q = 93.0 DB
LOSHA = 90.3 DB
LOSHA(80) = 89.8
LOSHA(85) = 89.6
LOSHA(90) = 89.2

(C) METROSONICS, IN

```
GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

DB652 V5.7S S/N 1439
SOUND SURVEY SYSTEM

DB-301/36    S/N 2751
BASELINE        60 DB
DYNAMIC RANGE   64 DB
SAMPLE RATE     4/SEC
STANDBY =    01:33:58
LOGGING =    07:52:25
SAMPLES =      113382
INTERRUPTS =        2
SITE  DPS
DATE  8/2/82
USER  Jim Graves

SAMPLE DISTRIBUTION
   (1 DB BY 1%)

       5%   10%   15%
SPL---+-----+-----+--
 60+
   .
   +
   +
   *
 65*
   *
   **
   *
   **
 70**
   ***
   ****
   ***
   ***
 75***
   ***
   ***
   ***
   ***
 80***
   ***
   ***
   ***
   ****
 85******
   *******
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 90******
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 95+
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100.
   .
   .
   .
   .
105.
   .
   .
   .
   .
1 0.
   .



1_5




120

SPL---+-----+-----+--
       5%   10%   15

EXCEEDANCE LEVELS

L( 0.00) =  111 DB
L( 0.10) =  101 DB
L( 1.00) =   96 DB
L( 2.00) =   93 DB
L(10.00) =   90 DB
L(20.00) =   89 DB
L(30.00) =   87 DB
L(33.33) =   87 DB
L(40.00) =   86 DB
L(50.00) =   84 DB
L(60.00) =   80 DB
L(66.67) =   78 DB
L(90.00) =   70 DB
L(99.00) =   64 DB

  COMPUTATIONS

L E Q =   86.6 DB
LOSHA =   84.9 DB
LOSHA(80) =  84.3
LOSHA(85) =  83.5
LOSHA(90) =  76.7

DBI METROSONICS,IN
```

GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

DN652 V5.7S S/N 1439
SOUND SURVEY SYSTEM

DB-301/36 S/N 2891
BASELINE 60 DB
DYNAMIC RANGE 64 DB
SAMPLE RATE 4/SEC
STANDBY = 00:00:46
LOGGING = 07:58:01
SAMPLES = 114725
INTERRUPTS = 1
SITE DPS
DATE 8/3/82
USER Jim Graves

SAMPLE DISTRIBUTION
(1 DB BY 1%)

```
      5%   10%   15%
SPL---+----+----+---
 60+
   .
   .
   +
   +
 65+
   *
   **
   **
   **
 70**
   **
   **
   ***
   ***
 75***
   ***
   ***
   ***
   ***
 80****
   ***
   ***
   ***
   ***
 85***
   ***
   ****
   *****
   *******
 90*******
   ******
   *****
   **
   *
 95*
   +
   +
   +
   .
100.
   .
   .
   .
   .
105.
   .
   .
   .
   .
110.
   .

   .
115

120

SPL---+----+----+
      5%   10%   15
```


EXCEEDANCE LEVELS

L(0.00) = 113 DB
L(0.10) = 103 DB
L(1.00) = 96 DB
L(2.00) = 95 DB
L(10.00) = 92 DB
L(20.00) = 90 DB
L(30.00) = 89 DB
L(33.33) = 88 DB
L(40.00) = 86 DB
L(50.00) = 83 DB
L(60.00) = 80 DB
L(66.67) = 78 DB
L(90.00) = 70 DB
L(99.00) = 64 DB

COMPUTATIONS

L E Q = 87.8 DB
LOSHA = 86.0 DB
LOSHA(80) = 85.4
LOSHA(85) = 84.7
LOSHA(90) = 81.8

DDD METROSONICS, IN

```
  GEORGIA  TECH.
 SAFETY + HEALTH
ATLANTA, GA 30332
 (404) 894-3806

DB652 V5.79 S/N 1439
SOUND SURVEY  SYSTEM

DB-301/36    S/N 2891
BASELINE        60 DB
DYNAMIC RANGE   64 DB
SAMPLE RATE     4/SEC
STANDBY =    02:34:40
LOGGING =    05:53:14
SAMPLES =       84777
INTERRUPTS =        3
SITE  DPS
DATE  8/2/82
USER  Bob Shanks

SAMPLE  DISTRIBUTION
    (1 DB BY 1%)

        5%   10%   15%
SPL----+-----+-----+--
 60**
   *
   *
   *
   *
 65*
   *
   *
   *
   **
 70**
   **
   ****
   *****
   ****
 75****
   *****
   ****
   ****
   ***
 80**
   **
   **
   **
   ***
 85**
   **
   **
   **
   **
 90**
   *
   *
   **
   ***
 95****
   ***
   ***
   ***
   ***
100*
   *
   *
   +
   +
105.
   .
   .
   .
   .
110.
   .
   .
   .
   .
115.



120


SPL----+-----+-----+
       5%   10%   15

EXCEEDANCE LEVELS

L( 0.00) = 115 DB
L( 0.10) = 108 DB
L( 1.00) = 102 DB
L( 2.00) = 101 DB
L(10.00) =  98 DB
L(20.00) =  95 DB
L(30.00) =  89 DB
L(33.33) =  88 DB
L(40.00) =  85 DB
L(50.00) =  80 DB
L(60.00) =  77 DB
L(66.67) =  76 DB
L(90.00) =  69 DB
L(99.00) =  60 DB

  COMPUTATIONS

L E Q =  92.6 DB
LOSHA =  89.6 DB
LOSHA(80) =  89.2
LOSHA(85) =  88.8
LOSHA(90) =  88.2

DMI METROSONICS, IN
```

```
GEORGIA  TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

DB652 V5.78 S/N 1439
SOUND SURVEY  SYSTEM

DB-301/36    S/N 2890
BASELINE          60 DB
DYNAMIC RANGE   64 DB
SAMPLE RATE      4/SEC
STANDBY =    00:01:32
LOGGING =    07:58:32
SAMPLES =       114851
INTERRUPTS =         1
SITE DPS
DATE 8/2/82
USER Bob Sowles

SAMPLE  DISTRIBUTION
    (1 DB BY 1%)

      5%   10%   15%
SPL---+----+----+--
 60*
   *
   *
   +
   +
 65+
   +
   *
   *
   *
 70*
   *
   **
   ***
   ****
 75****
   ****
   ****
   ***
   ***
 80***
   ***
   ***
   **
   **
 85**
   **
   **
   **
   **
 90**
   **
   **
   **
   ***
 95****
   ****
   ****
   ****
   ***
100***
   ****
   **
   *
   *
105*
   +
   +
   +
   .
110.
   .
   .
   .
   .
115.
   .
   .
   .
120
   .
   .
SPL---+----+----+--
      5%   10%   15

EXCEEDANCE LEVELS

L  0.00) = 123 DB
L  0.10) = 110 DB
L  1.00) = 106 DB
L  2.00) = 104 DB
L 10.00) = 101 DB
L 20.00) =  97 DB
L 30.00) =  95 DB
L 33.33) =  94 DB
L 40.00) =  90 DB
L 50.00) =  85 DB
L 60.00) =  81 DB
L 66.67) =  79 DB
L 90.00) =  72 DB
L 99.00) =  61 DB

  COMPUTATIONS

L E Q =  95.8 DB
LOSHA =  93.0 DB
LOSHA(80) =  92.8
LOSHA(85) =  92.5
LOSHA(90) =  92.2

DOD METROSONICS, IN
```

GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

DB652 V5.7S S/N 1439
SOUND SURVEY SYSTEM

```
DB-301/34     S/N 2885
BASELINE         40 DB
DYNAMIC RANGE    64 DB
SAMPLE RATE      4/SEC
STANDBY =     00:03:38
LOGGING =     07:58:28
SAMPLES =       114833
INTERRUPTS =         2
```

SITE DPS

DATE 8/2/82

USER Brian Tindall

SAMPLE DISTRIBUTION
(1 DB BY 1%)

```
      5%   10%   15%
SPL----+-----+-----+---
 40




 45


   .
   .
 50.
   .
   .
   +
   *
 55*
   *
   *
   *
   *
 60*
   *
   *
   ****
   ******
 65**
   **
   **
   **
   **
 70**
   ***
   ***
   ******
   ******
 75*****
   *****
   *****
   ****
   ****
 80***
   ***
   ***
   **
   **
 85**
   **
   *
   *
   *
 90*
   *
   *
   *
   +
 95+
   +
   +
   +
   +
100.
   .
   .
   +
SPL----+-----+-----+
      5%   10%   15
```

EXCEEDANCE LEVELS

```
L( 0.00) = 103 DB
L( 0.10) = 103 DB
L( 1.00) =  99 DB
L( 2.00) =  95 DB
L(10.00) =  86 DB
L(20.00) =  82 DB
L(30.00) =  79 DB
L(33.33) =  78 DB
L(40.00) =  76 DB
L(50.00) =  74 DB
L(60.00) =  73 DB
L(66.67) =  71 DB
L(90.00) =  63 DB
L(99.00) =  54 DB
```

COMPUTATIONS

```
L E Q =  85.4 DB
LOSHA =  80.9 DB
LOSHA(80) =  79.1
LOSHA(85) =  77.5
LOSHA(90) =  75.2
```

DXD METROSONICS, IN

APPENDIX B

Air Sampling Results

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant IOWA POWER & LIGHTS COMPANY
Des Moines Power Station (DPS)

Materials Total Dust (TD)

Flow Rate = 2 lpm

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop				TD (mg/m^3)	
8/2/82	T-1 #4307	Matt Kouri Plant Attendant	0705	1438	906	453		1.46	
8/2/82	T-2 #7727	Bob Sowles Equipment Operator	0642	1440	956	478		4.18	
8/2/82	T-3 #7716	Rocky Vitiritto Equipment Operator	0718	1439	882	441		2.63	
8/2/82	T-4 #7169	Ron Reynolds Mechanic	0742	1532	940	470		1.14	
8/2/82	T-5 #7689	Gene Breton Mechanic	0745	1533	936	468		7.83	
8/2/82	T-6 #7702	Dan Earp Electrician	0753	1544	942	471		4.91	
8/3/82	T-7 #7702	Rocky Vitiritto Equipment Operator	0658	1440	924	462		3.04	

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant IOWA POWER & LIGHT COMPANY

Des Moines Power Station (DPS)

Materials Total Dust (TD)

Flow Rate = 2 lpm

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop				TD (mg/m^3)	
8/3/82	T-8 #7689	Bracy Skidmore Mechanic	0738	1540	964	482		9.31	
8/3/82	T-9 #7169	Bob Riegel Mechanic	0740	1541	962	481		5.57	
8/3/82	T-10 #7727	Brian Tindall Electrician	0751	1516	890	445		2.27	
8/3/82	T-11 #4307	Dan Earp Electrician	0753	1516	886	443		4.11	

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant IOWA POWER & LIGHT COMPANY
Des Moines Power Station (DPS)

Materials Iron (Fe) Arsenic (As)
Zinc (Zn)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			Fe (mg/m^3)	As (mg/m^3)	Zn (mg/m^3)
8/2/82	T-2 #7727	Bob Sowles Equipment Operator	0642	1440	956	478	0.010	<0.001	0.003
8/2/82	T-5 #7689	Gene Breton Mechanic	0745	1533	936	468	0.41	0.001	0.011
8/3/82	T-8 #7689	Bracy Skidmore Mechanic	0738	1540	964	482	0.65	0.001	0.14
8/3/82	T-11 #4307	Dan Earp Electrician	0753	1516	886	443	0.141	<0.001	0.006

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant IOWA POWER & LIGHT COMPANY

Des Moines Power Station (DPS)

Materials Total Respirable Dust (TRD)

- Coal Dust -

Flow Rate = 1.7 lpm

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop				TRD (mg/m3)	
8/2/82	R-1 #7012	Jim Graves Cat Operator	0759	1542	787.1	463		0.47	
8/2/82	R-3 #7644	Tom Bartram Breaker House	0800	1539	780.3	459		1.14	
8/2/82	R-4 #7709	John Taylor Distributor Floor	0803	--	Void	--		--	
8/3/82	R-2 #7012	Gene Breton Mechanic (Pulverizer Repair)	0743	1530	793.9	467		4.33	
8/3/82	R-5 #7709	Lester Dawson Fuel Handler	0745	1540	807.5	475		0.92	

Table B-5

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant IOWA POWER & LIGHT COMPANY

Des Moines Power Station (DPS)

Material Total Respirable Dust

Free Silica

Date	Sample Number	Description	Sampling Period* Start	Sampling Period* Stop	Total Sample Weight (mg)	Sample Volume (Liters)	Concentration TRD (mg/m^3)	Concentration	Concentration SiO_2 (%)	OSHA & ACGIH** Standard $\frac{10\ mg/m^3}{\%\ SiO_2+2}$
8/2/82	R-3 #7644	Tom Bartram Breaker House	0800	1539	--	780.3	1.14		2.4	2.3
8/3/82	R-2 #7012	Gene Breton Mechanic (Pulverizer Repair)	0743	1530	--	793.9	4.33		2.1	2.4

Table B-6

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant IOWA POWER & LIGHT COMPANY

Des Moines Power Station (DPS)

Materials Nitrogen Dioxide (NO_2)

Carbon Monoxide (CO)

Flow Rate = 20 cc/min

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentrations			
			Start	Stop				NO_2 (ppm)		CO (ppm)
8/2/82	#3357	Area Sample - #11 Boiler								
		by middle burner, 2nd floor	0815	1403	5.24	348		N.D.		
8/2/82	#3351	Area Sample - #11 Boiler								
		by middle burner, 2nd floor	0815	1403	7.17	348				5.0
8/3/82	#3351	Area Sample - #10 Boiler								
		by middle burner, 2nd floor	0807	1408	7.44	361		N.D.		
8/3/82	#3357	Area Sample - #10 Boiler								
		by middle burner, 2nd floor	0807	1408	5.43	361				5.0

N.D. = None Detected

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant IOWA POWER & LIGHT COMPANY

Des Moines Power Station (DPS)

Materials Asbestos

Date	Sample Number	Description	Sampling Period Start	Sampling Period Stop	Sample Volume (Liters)	Sample Time (Min.)	Concentration Asbestos Fibers*/cc
8/2/82	A-1 #7719	Area Sample - North Side of #6 Condenser - Ground Floor	0809	1402	706	353	0.03
8/3/82	A-2 #7719	Area Sample - North Side of #7 Condenser - Ground Floor	0802	1407	730	365	0.09
8/3/82	B-1	Bulk Sample of Insulation From Turbine/Generator #			47% Chrysotile Asbestos		

* Greater than 5 micrometers in length

APPENDIX C

Results of Bulk and Wipe Sample Analysis

Asbestos

8/3/82	Bulk Sample From Turbine/Generator #1 Asbestos = 42 $\pm$ 5% chrysotile asbestos

Polychlorinated Biphenyls

8/3/82	Wipe From #62 Power Station 2.5 micrograms (1262*)
8/3/82	Wipe From #71 Power Station 14.0 micrograms (1262*)

*a PCB arochlor number

APPENDIX D

Sampling and Analytical Methods

ASBESTOS (airborne)

Samples for the determination of airborne asbestos fibers were collected by drawing air at measured flowrates through open-face cassettes containing 37-millimeter diameter cellulose ester membrane filters (Millipore, Type AA) using battery-powered, portable pumps. After collection of each sample the cassette was covered and sealed immediately for transport to the laboratory.

Each sample was analyzed subsequently for asbestos fibers using the microscopic technique currently specified by the National Institute for Occupational Safety and Health (NIOSH). Briefly, the technique consisted of the following steps: a wedgeshaped sector of each filter was cut carefully from the sample and mounted on a standard microscope slide, using a high-viscosity solution of membrane filter material in a 1:1 mixture of diethyl oxalate and dimethyl phthalate to render the filter transparent. Asbestos fibers, defined as particules having aspect ratios (apparent length to width) of three or greater, which were observable on the surface of the filter were counted using a binocular microscope equipped with 10X eyepieces and a 40X objective with phase contrast illumination. Porton reticle fields, selected at random on the sample, were examined and fibers greater than five micrometers in length were counted until either of two conditions was satisfied:

1. A minimum of 100 fibers was counted in 20 or more fields.

2. A minimum of 100 fields was examined.

Results of the microscopic analyses were used in conjunction with field sampling data (measured flowrates and durations of sampling) to calculate the concentrations of airborne asbestos fibers corresponding to each sample in units of fibers greater than five micrometers in length per cubic centimeter of air (fibers 5um per cc).

CARBON MONOXIDE

Sampling for carbon monoxide (CO) was conducted by using the following two techniques.

Short-term area sampling (direct reading instantaneous) was performed either by drawing measured volumes of air through a length of stain detector tube via a hand-operated sampling pump, or by a direct-reading meter.

In the detector tube system, the CO indication is based upon the reduction of potassium palladosulfite impregnated silica gel giving a color change of yellow to brown in the presence of CO. The length of stain of the detector chemical is proportional to the CO concentration (in ppm) and must be matched to a chart corresponding to the number of pump strokes employed (1 full stroke = 100 cc) on the instruction sheet which accompanies the tubes.

The basic principle of operation of the direct reading meter involves drawing air (pre-cleansed to remove interferences) through an electrochemical sensor cell at a nominal flowrate of 700 cc/minute. The sensor cell is composed of a catalytically active sensing electrode (platinum), a counter electrode, a reference electrode and an aqueous sulfuric acid solution as the electrolyte. In the direct reading meter, the electrochemical process is carried out at a potential-controlled electrode. The current measured upon introduction of CO to the sensor cell is the result of the electro-oxidation of CO to carbon dioxide (CO_2) and is proportional to the partial pressure of CO in the sampled air.

METALS AND TOTAL DUST

Samples to be analyzed for metallic elements and total dust were collected by drawing air at measured flowrates through cassetted cellulose ester membrane filters using battery-powered, portable pumps.

The mass of particulate matter collected on each filter was determined gravimetrically in the laboratory as the difference between the tare weight of the filter and the weight of the filter after sampling and equilibration to balance room conditions.

For the analyses of metals, the filter matrices were destroyed by ashing with concentrated nitric acid, and the residues dissolved in either dilute hydrochloric acid or dilute nitric acid. The resultant solutions were aspirated into the flame of an atomic absorption spectrophotometer equipped with the appropriate hollow-cathode lamps. After scattered light corrections, the absorbances at the analytical wavelengths of the samples were compared to the absorbances to aqueous standard solutions containing known amounts of the metal analytes. Analytical results, which include any necessary corrections for blank and recovery determinations run in parallel with the analyses, were used in conjunction with the measured flowrates and sampling durations to calculate the concentrations of airborne analyte species, expressed in units of milligrams of analyte per cubic meter of air (mg/m^3).

NITROGEN DIOXIDE

Integrated, long-term sampling was performed by drawing air at measured flowrates (nominal 10-20 cm^3/min) through a color change detector tube by a battery-powered, portable pump.

In the detector tube sampling system, the indication is based on the reaction of nitrogen dioxide with diphenyl benzidine which provides a color change of yellow to dark blue-grey. The length of stain shown by the detector chemical is proportional to the nitrogen dioxide concentration which must be calculated in conjunction with the air volume sampled.

NOISE DOSIMETRY

Noise dosimetry studies of employee noise exposures were made using DuPont, Model D-376, Audio Dosimeters, set for a 90 dBA cutoff.

Sound levels reaching the employee were detected by a non-directional ceramic microphone worn on the shirt collar. This input is attenuated using the "A" weighting scale described in the American National Standards Institute S1.4-1971 "Type 2 Specification". If the microphone picks up any continuous sound over 115 dBA, it is recorded and stored for later inspection.

Next, noise below the cutoff level, 90 dBA, is removed on a continuous basis. The ratios of actual exposure to established limits at every sound level between 90 and 115 dBA are calculated and integrated with time to give the actual exposure during the workday as a percentage of that permitted by the regulations.

Data storage is accomplished by means of an electroplating reaction that occurs within an integrating memory cell. The information is stored in the cell until it is retrieved in a DuPont, Model R-225 readout instrument by reversing the electroplating reaction. The memory cell is automatically cleaned for reuse as the exposure information is retrieved.

Prior to use, the Audio Dosimeter battery is checked with an internal battery check and calibrated at two sound levels with a DuPont, Model C-114, calibrator.

RESPIRABLE DUST AND FREE SILICA

Samples to be analyzed for "respirable" dust and crystalline free silica were collected by using battery-powered, portable pumps to draw air at a nominal flowrate of 1.7 liters per minute through 37-millimeter diameter polycarbonate membrane filters, 0.8 micrometer pore size contained in cassettes preceded by 10-millimeter nylon cyclone particle size selectors.

The mass of particulate matter collected on each filter was determined gravimetrically as the difference between the weights of the filters before and after sampling, using a five-place analytical balance in a temperature-and-humidity controlled environment. The samples then were transferred into beakers containing small volumes of a surfactant solution (5% Triton X-100 in distilled water) and placed in an ultrasonic vibrator bath to dislodge particulate matter from the filter matrices. The resultant suspensions then were passed through 25-millimeter diameter polycarbonate membrane filters, 0.4 micrometer pore size, using vacuum filtration to achieve uniform sample deposits. After drying, the filters were placed on the rotating sample state of an X-ray diffractometer equipped with data control and data processor to provide both digital and graphic indication of detector responses. The masses of crystalline free silica (quartz, cristobalite, and tridymite) on the samples were determined by comparison of the relative responses, at the appropriate diffraction angles, of the scintillation detector to the copper K a-illuminated samples with the responses at the same angles to standards prepared by uniform deposition of known amounts of the pure materials on the same filter matrix.

Results of the gravimetric and X-ray diffraction analyses, which included any necessary corrections for blank determinations run in parallel with the analyses, were used to compute the "% SiO_2" (percent free silica) in each sample; the resultant figure then was used to compute the eight-hour, time-weighted average limit for exposure to the particulate matter collected in that sample. Results of the gravimetric analyses were used in conjunction with sampling data (measured flowrates and durations of sampling) to calculate concentrations of airborne particulate matter collected on the samples, expressed in milligrams of particulate matter per cubic meter of air (mg/m3).

APPENDIX E

Toxicological Information

ASBESTOS

Asbestos is a generic term referring to various fibrous mineral silicates, including chrysotile (hydrated magnesium silicate), amosite (iron-magnesium silicate), crocidolite (sodium-iron silicate), tremolite (calcium-magnesium silicate), anthophyllite (another iron-magnesium silicate), and actinolite (calcium-magnesium-iron silicate).

The potential health hazard associated with exposure to asbestos results from inhalation of airborne fibers; small asbestos fibers can pass readily through the upper respiratory tract and be deposited in the terminal bronchioles of the lung. There they can produce a local irritation which the body attempts to overcome by initiating a tissue response resulting in the encapsulation of the fibers and consequent formation of "asbestos bodies". Asbestos fibers are the causative agents in cases of asbestosis, a progressive disease characterized by diffuse interstitial fibrosis and, at times, pleural changes of fibrosis and calcification. It is often evident by such clinical signs as rales and dyspnea. In its severe form, asbestosis can contribute to, and result in, death due to the inability of the body to obtain oxygen or the heart to pump blood through the scarred lungs.

Exposure to airborne asbestos fiber also has been associated with bronchogenic carcinoma (a malignancy of the interior of the lung), mesothelioma (a diffuse malignancy of the lining of the chest or abdomen), and cancer of the stomach, colon, and rectum. Cigarette smoking can enhance the incidence of bronchogenic carcinoma from this substance.

In order to protect workers from such occupational hazards, the Occupational Safety and Health Administration (OSHA) has established a limit of two fibers (longer than five micrometers) per cubic centimeter of air as an eight-hour, time weighted average (TWA) concentration limit. This OSHA standard also specifies a ceiling (peak) exposure limit of ten fibers per cubic centimeter of air. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value of five fibers (longer than five micrometers) per cubic centimeter of air. The National Institute of Occupational Safety and Health (NIOSH) has recommended a daily TWA exposure limit of 0.1 fiber per cubic centimeter of air, with a peak concentration limit of 0.5 fibers per cubic centimeter bases on a 15 minute sample period.

CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless gas generally produced by incomplete combustion of organic or carbonaceous materials. It is a serious hazard in many processes in the chemical, iron and steel, pottery, automobile, and mining industries.

Of all the gases that have poisonous effects upon man and animals, carbon monoxide is the most widely encountered. It exerts its effects by combining with the hemoglobin of the blood and interrupting the normal oxygen supply to the body tissues. Although this resultant oxygen deficiency is a reversible chemical asphyxia, nevertheless, damage done by severe asphyxia from any cause may not be reversible.

The acute effects of carbon monoxide exposures are dependent on the percentage saturation of hemoglobin with carbon monoxide, which in turn is dependent on the duration of exposure, concentration of carbon monoxide, the ambient temperature, and the health status and metabolic efficiency of the worker. The approximate relationship is shown in the following table.

Atmospheric Carbon monoxide concentration (ppm)	Half-time for accumulation (min)	Carboxy-hemoglobin concentration at equilibrium %	Principal Symptoms
50	150	7	Slight headache
100	120	12	Moderate headache and dizziness
250	120	25	Severe headache and dizziness
500	90	45	Nausea, vomiting collapse possible
1,000	60	60	Coma
10,000	5	95	Death

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established a permissible exposure limit (PEL) for an eight-hour, time-weighted average, (TWA) exposure of 50 ppm to maintain carboxyhemoglobin levels below 10%. The National Institute for Occupational Safety and Health recommends a time-weighted average exposure of 35 ppm for an eight-hour workday, with a ceiling concentration of 200 ppm. ACGIH currently lists as "tentative value" a short-term exposure limit (up to 15 minutes) of 400 ppm.

COAL DUST

Coal is a native, black or brownish, brittle or soft substance consisting chiefly of carbon, but also of hydrogen, nitrogen, oxygen and other elements (Si,P,As,Fe, etc.).

A commonly used term for chest disease resulting from inhalation of coal dust is coal workers' pneumoconiosis. Another frequently used term is anthrosilicosis, an appropriate description, since all coals contain not only carbon, but varying amounts of silica.

In chronic respiratory disease of coal workers, the onset is gradual, often forcing the patient to seek medical advice for the first time only after a bacterial infection or heavy exposure to dust in a mine accident. Cough, wheezing, severe dyspnea, and sputum production varies with infection and smoking habits. The sputum is usually black, and in advanced disease large amounts of thick material referred to as melanosis are produced indicating cavities caused by aseptic necrosis. Tuberculosis and bacterial pneumonia, although more manageable with modern chemotherapy, are serious complications. Pulmonary arterial circulation involvement and right heart failure are secondary to emphysema and hypoxia leading to increasing disability and death.

The Occupational Safety and Health Administration (OSHA) has established an eight-hour, time-weighted average (TWA) concentration limit of 2.4 mg/m^3 for "respirable" coal dust containing less than five percent quartz, and established the following formula as an eight-hour, TWA concentration limit for respirable coal dust containing more than five percent quartz:

$$TLV = \frac{10\ mg/m^3}{\%\ SiO_2 + 2}$$

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted an eight-hour, TWA threshold limit value of 2 mg/m^3 for respirable coal dust containing less than five percent quartz. If the coal dust contains more than five percent quartz, ACGIH also recommends the respirable mass formula established by OSHA. The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of 0.05 mg/m^3 of free silica in respirable dusts.

NITROGEN OXIDES
(NO_x)

"Nitrogen oxides" here refers to the mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). Since nitrogen dioxide in the working environment results, at least in part, from oxidation of nitric oxide, occupational exposures are usually to mixtures of these gases rather than to either gas alone. Nitric oxide is a colorless gas which reacts with oxygen to form nitrogen dioxide at ordinary temperatures. Nitrogen dioxide is a reddish-brown gas with a characteristic odor, or (below 21.1°C) a yellow liquid.

Exposure to high concentrations of nitrogen oxides may result in severe pulmonary irritation and methemoglobinemia. The former is believed to be caused by the nitrogen dioxide portion, while the latter is mainly caused by nitric oxide. Typically, acute exposure may produce immediate malaise, cyanosis, cough, dyspnea, chills, fever, headache, nausea, and vomiting. Collapse and death may occur if exposure is sufficiently high. When lower concentrations are encountered, there may be only mild signs of bronchial irritation, followed by a five to twelve hour symptom-free period. Many fatalities occur because of the suddenness and severity of the effects and the characteristic delay in onset. If the acute episode is survived, "bronchiolitis fibrosa obliterans" (severe and increasing dyspnea with fever and cyanosis) may develop usually within a few days but may be latent for as long as six weeks.

Chronic exposure may result in pulmonary dysfunction. The most common complaint is of dyspnea upon exertion. Nitrogen dioxide is about four or five times as toxic as nitric oxide.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of 25 ppm as a standard for occupational exposures to nitric oxide and a ceiling concentration limit of five ppm, not to be exceeded at any time, for nitrogen dioxide. This ceiling limit for nitrogen dioxide was adopted on the basis of prevention of immediate injury or adverse physiologic effects from prolonged daily exposures. The National Institute for Occupational Safety and Health (NIOSH) has recommended a 40-hour work week, TWA concentration limit of 25 ppm for nitric oxide and a ceiling concentration limit (up to 15 minutes) of one ppm for nitrogen dioxide.

NOISE

The major potential health hazard associated with exposure to noise lies in the possibility of producing permanent hearing loss. Factors which play a role in deciding how much permanent hearing loss will be sustained after exposure to high noise levels include the level and frequency of the noise, the duration of exposure per day, the number of years of repeated daily exposure, and individual susceptibility (age, genetic make-up, diet, and use of autotoxic drugs are just some of the variables which determine individual susceptibility).

The other adverse effects suspected as being caused by high noise levels include physiological disturbances (high blood pressure, aural pain, nausea and impaired muscular control when exposure is severe), and an increase in the accident frequency rate resulting from interference with speech communication and the disrupting of concentration. Also, some temporary hearing loss results from daily exposure to high noise levels, reportedly because the hair cells in the inner ear become fatigued and can no longer respond as well.

The standard as set by the Occupational Safety and Health Administration (OSHA) is based on daily time-weighted average exposure limits (over an eight-hour period) which, it is thought, will protect most workers from serious hearing loss.

The elements of the OSHA standard are:

1. The acceptable level of continuous noise (amplitude peaks less than one second apart) for exposures of eight hours duration is 90 decibels (dB) as measured on the A-weighted integrating network of a Type II sound level meter set on slow response, which approximates the response of the normal human ear to sound.

2. For each additional 5 dBA above 90, the permissible exposure time is reduced by half (see Table 1 below).

TABLE 1

PERMISSIBLE NOISE EXPOSURES

Sound Level (dBA)Hours/Day	Duration
90	8
92	6
95	4
97	3
100	2
102	1½
105	1
110	½
115	¼ or less

3. No exposure to continuous noise levels in excess of 115 dBA is acceptable, regardless of duration.

4. Exposure to impulsive or impact noise (amplitude peaks greater than one second apart) in excess of 140 dB peak sound pressure level is unacceptable.

5. When workers are being overexposed on the basis of the criteria in Table 1, feasible administrative and/or engineering controls shall be utilized. If such controls fail to reduce noise exposure to within these limits, personal protective equipment shall be provided and its use strictly enforced.

6. In all cases where the noise levels exceed an equivalent noise level of 85 dBA, including noise levels from 80 to 130 dBA, a continuing effective hearing conservation program shall be administered. The allowable duration of exposure is determined by the formula:

$$\textbf{Allowable time (Hours)} = \frac{32}{2^{(L-80)/5}}$$

where L is the sound level measured on the A weighted scale (dBA).

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, as it is in most jobs in industrial settings, the combined effect shall be considered, rather than the individual effect of each. This combined effect, or total exposure, is determined by the following exposure formula.

$$\textbf{Exposure} = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$$

Where C_n is the actual time spent at sound level, n (in dBA), and T_n is the allowable time spent at sound level, n.

OSHA has defined an effective hearing conservation program, but parts of the definition have been stayed. The portions which have not been stayed are summarized below:

1. Baseline audiometric testing must be completed by August 22, 1982, and repeated annually thereafter. All audiograms must be kept for the duration of employment.

2. Audiometric tests must be given by a trained individual and the audiometer must meet the ANSI S3.6-1969 criteria. Audiometer calibrations must be done as stated in the OSHA standard.

3. Audiograms showing a significant threshold shift must be reviewed by an audiologist, otolaryngologist, or qualified physician.

4. Employees must be notified of audiogram results within 21 days of receipt of the results. Hearing protection must be worn by employees having a significant threshold shift when working in areas where noise levels exceed 85 dBA.

5. Employees exposed to an equivalent noise level of 85 dBA or greater must have annual training which includes discussions of the effects of noise on man, the use of hearing protection, and audiometric testing.

6. When employees are exposed to greater than 90 dBA a written plan to reduce noise exposures to less than an equivalent noise level of 90 dBA must be formed. The plan may include both engineering and administrative controls.

NUISANCE DUST

In contrast to fibrogenic dusts which cause scar tissue to be formed in lungs when inhaled in excessive amounts, so-called "nuisance" dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts have the following characteristics:

(1) The architecture of the air spaces remains intact.

(2) Collagen (scar tissue) is not formed to a significant extent.

(3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by rigorous skin cleansing procedures necessary for their removal. They do not appear to have a predisposing effect on tuberculosis or other infection and do not cause impaired lung function.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established time-weighed average (TWA) threshold limit values of 30 mppcf (millions of particles per cubic foot of air), based on impinger samples counted by light-field techniques or 10 mg/m^3 of total dust containing less than 1% quartz, or 5 mg/m^3 respirable dust. The Occupational Safety and Health Administration (OSHA) has established TWA standards of 50 mppcf or 15 mg/m^3 for total dust containing less than 1% quartz, or 15 mppcf or 5 mg/m^3 for respirable dust.

Quite often an industrial hygienist will use a gravimetric analysis for total dust when sampling for dusts with unknown toxicity. While the results may be compared to the nuisance dust standard for a base line reading, the dusts of unknown toxicity should in no way be considered nuisance dusts because the potential for harm has not been established.

POLYCHLORINATED BIPHENYLS (PCBS)

PCBs ($C_{12}H_{10-x}Cl_x$ chlorodiphenyls) are diphenyl rings in which one or more hydrogen atoms are replaced by chlorine atoms. Most widely used are trichlorophenyl (42% chlorine) containing three chlorine atoms in unassigned positions and pentachlorophenyl (54% chlorine) containing five chlorine atoms in unassigned positions. These compounds are light, straw-colored liquids with typical chlorinated aromatic odors; 42% chlorodiphenyl is a mobile liquid and 54% chlorodiphenyl is a viscous liquid. In industry, PCBs can enter the human body mainly via inhalation of fume or vapor and percutaneous absorption of liquid.

The major effects that have been found in workers exposed to PCBs are chloracne, liver injury, and irritation of skin and mucous membranes. Generally, the toxic effects are dependent upon the degree of chlorination; the higher the degree of substitution, the stronger the effects.

In humans, systematic effects are anorexia, nausea, edema of the face and hands, and abdominal pain. In a survey of 34 workers exposed to concentrations of up to 2.2 mg/m^3, complaints were of a burning sensation of the face and hands, nausea, and a persistent (uncharacterized) body odor. Cases of mild-to-moderate skin irritation with an acneform eruption have been reported in workers exposed to 0.1 mg/m^3.

PCBs are poorly metabolized and tend to accumulate in animal tissues, including humans. Currently, a possible link between PCBs exposure and cancer has been reported.

To protect against systemic intoxication, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established eight-hour, time-weighted average concentration limits of 1 mg/m^3 for chlorodiphenyl (42% chlorine) and 0.5 mg/m^3 for chlorodiphenyl (54% chlorine). ACGIH currently lists as "tentative" short-term exposure limits (up to 15 minutes) of 2 mg/m^3 and 1 mg/m^3 for the two substances, respectively.

Based on the findings of adverse reproductive effects, on its conclusion that PCBs are potential carcinogens in humans and on its conclusion that occupational and animal studies have not demonstrated on exposure level that will not subject the workers to possible liver injury, the National Institute for Occupational Safety and Health (NIOSH) recommends a TWA concentration limit of 1 microgram total PCBs per cubic meter of air (1 ug/m^3) for up to a 10-hour workday, 40-hour workload. The standards established by OSHA and ACGIH carry the "skin" notation, warning of the potential for percutaneous absorption; the specific concentration limits are based on the presumption that there is no concurrent exposure via the skin and oral ingestion routes.

The Environmental Protection Agency (EPA) has taken action under Toxic Substances Control Act (TSCA) aimed at controlling the production, distribution, use, and disposal of PCBs.

SILICEOUS DUSTS

Free silica (SiO_2, uncombined and independent of other elements) has three crystalline forms: quartz, tridymite, and cristobalite. All three forms have similar physiologic action. The potential health hazard associated with exposure to crystalline silica is that of inhalation of the dust. Inhalation of extreme concentrations of submicron particles can lead to diffuse, fulminating lung fibrosis within a few months. However, development of the more common chronic type of silicosis usually takes many years. The effect of repeated exposure is characterized by an initial generalized linear increase in lung density progressing to small nodules scattered throughout the lung tissue. If exposure continues, these nodules increase in size to the point where they interfere with respiration. Although silicosis rarely causes death, common complications include tuberculosis, chronic bronchitis and bacterial infections.

The Occupational Safety and Health Administration (OSHA) has established the following formula as an eight-hour, time-weighted average (TWA) concentration limit, based on the quartz content of total dust:

$$TLV = \frac{30\ mg/m^3}{\%\ SiO_2+2}$$

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted a TWA threshold limit value (TLV) formula based on the free crystalline quartz content for total dust:

$$TLV = \frac{30\ mg/m^3}{\%\ SiO_2+3}$$

OSHA and ACGIH both have established a formula applicable to calculate acceptable air concentrations of the respirable fraction of total dust:

$$TLV = \frac{10\ mg/m^3}{\%\ SiO_2+2}$$

If the free crystalline silica content is composed primarily of tridymite and/or cristobalite, one-half the value calculated from the formula for quartz must be used.

The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of 0.05 mg/m3 of free silica in respirable dust.

INDUSTRIAL HYGIENE SURVEY
at
IOWA POWER AND LIGHT COMPANY
Two Rivers Service Center
Gas Meter Shop

October 12, 1982

SUBMITTED BY:

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety and Health Division
Atlanta, Georgia

Project No. A-3312

PART B

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

Iowa Power and Light Company retained the Georgia Tech Engineering Experiment Station to conduct a limited industrial hygiene survey of its Gas Meter Shop located at the Two Rivers Service Center in Des Moines, Iowa. The survey was limited to evaluating noise, dust, and solvent exposures associated with abrasive blasting and painting. This survey served to measure the effectiveness of engineering controls and/or work practices which are utilized in the shop in reducing employee exposure to potentially harmful substances or agents.

The survey was conducted at the Gas Meter Shop on August 3, 1982. The field survey work was conducted by Mr. James L. Burson of the Georgia Tech Engineering Experiment Station, Safety and Health Division. Mr. Lynn Wallis assisted in the conducting of the survey. During the survey five samples were collected for four different substances or agents; four samples to determine personal exposures and one area sample. The survey included the collection and analysis for noise, total dust, xylene, and toluene.

This report presents the results of the industrial hygiene survey, a discussion of the findings, and one recommendation addressing noise monitoring.

II. INTRODUCTION

Iowa Power and Light Company retained the Georgia Tech Research Institute to conduct an industrial hygiene survey of the sandblasting and spray paint operations at the Two Rivers Service Center, Gas Meter Shop, in Des Moines, Iowa. The survey was conducted on August 3, 1982 by Mr. James L. Burson of Georgia Tech. Mr. Lynn Wallis assisted in the conduct of the survey. The survey was limited to measurement of employee exposure to noise and dust during operating of an abrasive blasting cabinet, and exposure to noise and solvents while spray painting in a spray booth.

The following report includes a discussion of the sampling and analytical results and recommendations based on these results in conjunction with a survey of the facilities and observations of work practices and procedures. Noise exposure measurments are presented in Appendix A. Dust and solvent measurements are compiled in Appendix B. Appendix C summarizes the sampling and analytical methods employed for this study. A brief discussion of toxicological considerations of the various substances monitored is included in Appendix D.

III. DISCUSSION AND RECOMMENDATIONS

A. Noise

Employees were monitored to determine their exposure to noise while operating an abrasive blasting cabinet and painting in a spray booth. The employees were monitored during a three hour period. Noise exposures for both employees were below the IOSH action level of 85 dBA and the IOSH permissible exposure level of 90 dBA for an eight-hour, time-weighted average. However, the noise exposures of both employees approached the IOSH 85 dBA action level (81.4 dBA and 82.2 dBA) for the sampling period.

The noise dosimeter printouts for the two employees monitored (Appendix A) show most of the noise during actual operation of the equipment to be between 85 and 90 dBA. Thus, operation of the abrasive blasting cabinet and paint booth for longer periods of time may result in noise exposures exceeding the 85 dBA action level.

> Recommendation #1 -Additional noise exposure measurements should be collected for operators of the abrasive blasting cabinet and spray booth. The samples should be full-shift measurements in order to sum noise from the operation of this equipment with noise received in the Gas Meter Shop during the balance of the shift. Several shifts should be monitored in order to develop a statistically valid sample.

B. Total Dust

One personal and one area sample for airborne dust concentration were collected during operation of the abrasive blasting cabinet for an approximate 2½ hour period of time. The employee was monitored during operation of the unit and "shake-down" of the dust collector unit. An area sampler was positioned by the dust collector unit located just outside the Gas Meter Shop in the garage area.

Results of the monitoring showed the employee exposure to be well below the IOSH PEL of 15 mg/m^3, and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 10 mg/m^3 for total nuisance dust, determined as an 8-hour, time-weighted average (TWA). The abrasive medium used in the cabinet was aluminum oxide (Al_2O_3) which is considered a nuisance particulate.

C. <u>Solvents</u>

The employee spray painting gas meters in the paint booth was monitored for solvent exposures over a 137 minute sample period. Bulk analysis of the paint used showed the major solvents to be xylene and toluene. Analysis of the personal sample collected in the breathing zone of the painter showed his exposure to be 12 ppm toluene and 9 ppm xylene. This exposure is well below the IOSH permissible exposure limit of 100 ppm for both toluene and xylene.

The ventilation of the spray booth was evaluated in a previous survey and demonstrated to be effective in removing the paint spray from the breathing zone of employees assuming proper spray painting procedures are utilized.

This Report Prepared By:

James L. Burson

James L. Burson, CIH
Occupational Safety and Health
Consultation Program

APPENDICES

APPENDIX A

Noise Exposure Measurements

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company Iowa Power and Light Company
Two Rivers Service Center - Gas Meter Shop

Date 8/3/82

Test by James Burson

Dosimeter Model No. Metrosonic 301

Operating Conditions ______

Calibrator Model No. ______ S/N ______

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
2751	-	Bob Zeis, Repairman	1455	177	81.4	69.9
		Operating Sandblasting Cabinet	1156			
2885	-	Rick Johnson, Repairman	1450	175	82.2	76.2
		Painting in Spray Booth	1156			

```
GEORGIA  TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

DB652 V5.78 S/N 1439
SOUND SURVEY  SYSTEM

DB-301/34   S/N 2885
BASELINE          40 DB
DYNAMIC RANGE   64 DB
SAMPLE RATE      4/SEC
STANDBY =    00:00:10
LOGGING =    02:54:41
SAMPLES =       41924
INTERRUPTS =        1
SITE Two Rivers Gas Meter
DATE 8/3/82
USER Rick Johnson

SAMPLE  DISTRIBUTION
    (1 DB BY 1%)

       5%   10%   15%
SPL-----+------+------+--
 40



 45
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 50*
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 55*
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 60*
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 65*
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 70*
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 75**
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 80**
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 85***
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  *******
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 90***
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  +
  .
 95.
  .
  .
  .
  .
100.
  .
  .
  .
SPL-----+------+------+
       5%   10%   15%

EXCEEDANCE LEVELS

L( 0.00) =  103 DB
L( 0.10) =   99 DB
L( 1.00) =   93 DB
L( 2.00) =   92 DB
L(10.00) =   90 DB
L(20.00) =   87 DB
L(30.00) =   86 DB
L(33.33) =   86 DB
L(40.00) =   84 DB
L(50.00) =   78 DB
L(60.00) =   73 DB
L(66.67) =   69 DB
L(90.00) =   49 DB
L(99.00) =   47 DB

  COMPUTATIONS

L E Q =  85.1 DB
LOSHA =  82.8 DB
LOSHA(80) =  82.2 D
LOSHA(85) =  81.7 D
LOSHA(90) =  76.2 D

DB METROSONICS, INC
```

GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

DB652 V5.78 S/N 1439
SOUND SURVEY SYSTEM

DB-301/36 S/N 2751
BASELINE 60 DB
DYNAMIC RANGE 64 DB
SAMPLE RATE 4/SEC
STANDBY = 00:00:14
LOGGING = 02:56:55
SAMPLES = 42461
INTERRUPTS = 1
SITE Two Rivers Gas Meter
DATE 8/3/82
USER Bob Zeis

SAMPLE DISTRIBUTION
(1 DB BY 1%)

```
       5%   10%   15%
SPL----+----+----+---
 60*****************10
   *
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   **
   *
 65**
   **
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 70**
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   ***
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 75**
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 80*
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 85******
   ********
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   *******
   ****
 90**
   *
   +
   +
   +
 95.
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   .
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100.
   .
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   .
105.
   .
110.
115.
   .
120
SPL----+----+----+
       5%   10%   15
```

EXCEEDANCE LEVELS

L(0.00) = 117 DB
L(0.10) = 99 DB
L(1.00) = 93 DB
L(2.00) = 91 DB
L(10.00) = 88 DB
L(20.00) = 87 DB
L(30.00) = 86 DB
L(33.33) = 85 DB
L(40.00) = 84 DB
L(50.00) = 77 DB
L(60.00) = 73 DB
L(66.67) = 70 DB
L(90.00) = 60 DB
L(99.00) = 60 DB

COMPUTATIONS

L E Q = 84.8 DB
LOSHA = 82.2 DB
LOSHA(80) = 81.4
LOSHA(85) = 80.8
LOSHA(90) = 69.9

III METROSONICS, IN

APPENDIX B

Air Sampling Results

Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power and Light Company

Two Rivers Service Center - Gas Meter Shop

Materials Total Dust (TD)

Flow Rate = 21 pm

Date	Sample Number	Description	Sampling Period Start	Sampling Period Stop	Sample Volume (Liters)	Sample Time (Min.)	Concentration		
								TD (mg/m^3)	
8/3/82	T-12	Bob Zeis Operating Sandblasting Cabinet	1235	1450	270	135		1.94	
8/3/82	T-13 #7644	Area Sample By Dust Collector in Garage	1203	1450	334	167		2.61	

Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power and Light Company

Two Rivers Service Center - Gas Meter Shop

Materials Toluene, Xylene

Flow Rate = 100 cc/min

Date	**Sample Number**	**Description**	**Sampling Period**		**Sample Volume (Liters)**	**Sample Time (Min.)**	**Concentration**		
			Start	Stop			Toluene (ppm)	Xylene (ppm)	
8/3/82	CT-1 3133	Rich Johnson Spray Painting	1236	1453	14.48	147	12	9	

APPENDIX C

Sampling and Analytical Methods

NOISE DOSIMETRY

Noise dosimetry studies of employee noise exposures were made using DuPont, Model D-376, Audio Dosimeters, set for a 90 dBA cutoff.

Sound levels reaching the employee were detected by a non-directional ceramic microphone worn on the shirt collar. This input is attenuated using the "A" weighting scale described in the American National Standards Institute S1.4-1971 "Type 2 Specification". If the microphone picks up any continuous sound over 115 dBA, it is recorded and stored for later inspection.

Next, noise below the cutoff level, 90 dBA, is removed on a continuous basis. The ratios of actual exposure to established limits at every sound level between 90 and 115 dBA are calculated and integrated with time to give the actual exposure during the workday as a percentage of that permitted by the regulations.

Data storage is accomplished by means of an electroplating reaction that occurs within an integrating memory cell. The information is stored in the cell until it is retrieved in a DuPont, Model R-225 readout instrument by reversing the electroplating reaction. The memory cell is automatically cleaned for reuse as the exposure information is retrieved.

Prior to use, the Audio Dosimeter battery is checked with an internal battery check and calibrated at two sound levels with a DuPont, Model C-114, calibrator.

TOTAL DUST

Samples to be analyzed for total dust were collected by drawing air at measured flowrates through cassetted polyvinyl filters, using battery-powered, portable pumps.

The mass of particulate matter collected on each filter was determined gravimetrically in the laboratory as the difference between the tare weight of the filter and the weight of the filter after sampling and equilibrium to balance room conditions.

Analytical results, which include any necessary corrections for blank determinations, were used in conjunction with the measure flowrates and sampling durations to calculate the concentrations of airborne analyte, expressed in unit of milligrams of analyte per cubic meter of air (mg/m^3).

APPENDIX D

Toxicological Information

NOISE

The major potential health hazard associated with exposure to noise lies in the possibility of producing permanent hearing loss. Factors which play a role in deciding how much permanent hearing loss will be sustained after exposure to high noise levels include the level and frequency of the noise, the duration of exposure per day, the number of years of repeated daily exposure, and individual susceptibility (age, genetic make-up, diet, and use of autotoxic drugs are just some of the variables which determine individual susceptibility).

The other adverse effects suspected as being caused by high noise levels include physiological disturbances (high blood pressure, aural pain, nausea and impaired muscular control when exposure is severe), and an increase in the accident frequency rate resulting from interference with speech communication and the disrupting of concentration. Also, some temporary hearing loss results from daily exposure to high noise levels, reportedly because the hair cells in the inner ear become fatigued and can no longer respond as well.

The standard as set by the Occupational Safety and Health Administration (OSHA) is based on daily time-weighted average exposure limits (over an eight-hour period) which, it is thought, will protect most workers from serious hearing loss.

The elements of the OSHA standard are:

1. The acceptable level of continuous noise (amplitude peaks less than one second apart) for exposures of eight hours duration is 90 decibels (dB) as measured on the A-weighted integrating network of a Type II sound level meter set on slow response, which approximates the response of the normal human ear to sound.

2. For each additional 5 dBA above 90, the permissible exposure time is reduced by half (see Table 1 below).

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3. No exposure to continuous noise levels in excess of 115 dBA is acceptable, regardless of duration.

4. Exposure to impulsive or impact noise (amplitude peaks greater than one second apart) in excess of 140 dB peak sound pressure level is unacceptable.

5. When workers are being overexposed on the basis of the criteria in Table 1, feasible administrative and/or engineering controls shall be utilized. If such controls fail to reduce noise exposure to within these limits, personal protective equipment shall be provided and its use strictly enforced.

6. In all cases where the noise levels exceed an equivalent noise level of 85 dBA, including noise levels from 80 to 130 dBA, a continuing effective hearing conservation program shall be administered. The allowable duration of exposure is determined by the formula:

$$\textbf{Allowable time (Hours)} = \frac{32}{2^{(L-80)/5}}$$

where L is the sound level measured on the A weighted scale (dBA).

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, as it is in most jobs in industrial settings, the combined effect shall be considered, rather than the individual effect of each. This combined effect, or total exposure, is determined by the following exposure formula.

$$\textbf{Exposure} = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \dots + \frac{C_n}{T_n}$$

Where C_n is the actual time spent at sound level, n (in dBA), and T_n is the allowable time spent at sound level, n.

OSHA has defined an effective hearing conservation program, but parts of the definition have been stayed. The portions which have not been stayed are summarized below:

1. Baseline audiometric testing must be completed by August 22, 1982, and repeated annually thereafter. All audiograms must be kept for the duration of employment.

2. Audiometric tests must be given by a trained individual and the audiometer must meet the ANSI S3.6-1969 criteria. Audiometer calibrations must be done as stated in the OSHA standard.

3. Audiograms showing a significant threshold shift must be reviewed by an audiologist, otolaryngologist, or qualified physician.

4. Employees must be notified of audiogram results within 21 days of receipt of the results. Hearing protection must be worn by employees having a significant threshold shift when working in areas where noise levels exceed 85 dBA.

5. Employees exposed to an equivalent noise level of 85 dBA or greater must have annual training which includes discussions of the effects of noise on man, the use of hearing protection, and audiometric testing.

6. When employees are exposed to greater than 90 dBA a written plan to reduce noise exposures to less than an equivalent noise level of 90 dBA must be formed. The plan may include both engineering and administrative controls.

NUISANCE DUST

In contrast to fibrogenic dusts which cause scar tissue to be formed in lungs when inhaled in excessive amounts, so-called "nuisance" dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts have the following characteristics:

(1) The architecture of the air spaces remains intact.

(2) Collagen (scar tissue) is not formed to a significant extent.

(3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by rigorous skin cleansing procedures necessary for their removal. They do not appear to have a predisposing effect on tuberculosis or other infection and do not cause impaired lung function.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established time-weighed average (TWA) threshold limit values of 30 mppcf (millions of particles per cubic foot of air), based on impinger samples counted by light-field techniques or 10 mg/m^3 of total dust containing less than 1% quartz, or 5 mg/m^3 respirable dust. The Occupational Safety and Health Administration (OSHA) has established TWA standards of 50 mppcf or 15 mg/m^3 for total dust containing less than 1% quartz, or 15 mppcf or 5 mg/m^3 for respirable dust.

Quite often an industrial hygienist will use a gravimetric analysis for total dust when sampling for dusts with unknown toxicity. While the results may be compared to the nuisance dust standard for a base line reading, the dusts of unknown toxicity should in no way be considered nuisance dusts because the potential for harm has not been established.

TOLUENE

Toluene (toluol, methyl benzene) is a clear, colorless, non-corrosive liquid with a sweet, pungent odor. Toluene is readily absorbed from the lungs, the gastrointestinal tract, and to a small extent, through the intact skin. Part of the absorbed toluene is eliminated in the expired air, but a large percentage is excreted in the urine. The only industrial hazards of significance result from inhalation of excessive concentrations of vapor, prolonged skin contact with the liquid, and liquid contamination of the eyes.

With acute exposure, toluene acts predominantly upon the central nervous system as a depressant causing fatigue, headache, confusion, paresthesia, dizziness, and muscular incoordination. There is usually some delay in the development of symptoms, and hence the effects commonly appear at the end of the work shift. With sustained exposure to high concentrations, death may ensue from paralysis of the respiratory centers.

Continuous daily exposures to low concentrations of toluene vapors may give rise to a clinical picture of chronic intoxication. Such cases may show varying degrees of fatigue, general nervousness, insomnia, and loss of appetite and weight. Frequent and sustained skin contact with liquid toluene may result in the development of dermatitis because of the defatting properties of toluene as well as its local irritative action. Toluene does not cause the severe injury to the bone marrow characteristic of benzene.

The Occupational Safety and Health Administration has adopted the ANSI Z37.12-1967 Standard for Exposure to toluene, which established an eight-hour, time-weighted average of 200 ppm with a ceiling of 300 ppm and an acceptable peak exposure of 500 ppm for a duration of not more than ten minutes if encountered not more than once during an eight-hour workday. The American Conference of Governmental Industrial Hygienists has established a threshold limit value of 100 ppm as an eight-hour, time-weighted average. The National Institute for Occupational Safety and Health recommends an eight-hour, time-weighted average of 100 ppm with a ceiling of 200 ppm as determined by a sampling time of ten minutes. The American National Standards Institute, Inc. revised the ANSI Z37.12-1967 in 1974. It has established a new acceptable eight-hour, time-weighted average maximum for peaks above the acceptable ceiling concentration of 500 ppm for a duration of not more than 10 minutes if encountered not more than once a day.

XYLENE

Xylene (xylol, dimethyl benzene) is a clear colorless, flammable liquid having an aromatic odor similar to that of benzene and toluene. There are three isomers, ortho (1,2-dimethyl benzene), meta (1,3-dimethyl benzene), and para (1,4-dimethyl benzene). Commercial xylene is a mixture of the three forms with meta being the major component.

Inhalation is the primary exposure route for absorption of xylene. Although xylene can be absorbed through the skin, this is not a significant factor in industrial exposures.

Acute exposures to high concentrations result in a narcotic effect on the central nervous system which can lead to unconsciousness. Characteristic indications of acute exposure include giddiness, fatigue, palpitation, dyspnea, anxiety, and numbness of hands and feet.

Effects of chronic exposure to xylene are headache, fatigue, lassitude, irritability, and in some cases, digestive disturbances, but xylene does not produce the severe hematological changes characteristic of chronic benzene poisoning. Higher concentrations or longer exposure periods can cause eye and respiratory tract irritation, and the beginning of narcotic effects which may limit self-rescue ability. The defatting action on the skin can lead to severe dermatitis following repeated or prolonged contact.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average concentration limit of 100 ppm as a standard for occupational exposure. ACGIH currently lists as "tentative" short-term exposure limit (up to 15 minutes) of 150 ppm. The National Institute for Occupational Safety and Health (NIOSH) recommends a time-weighted average exposure of 100 ppm for up to a 10-hour workday, 40-hour workweek, with a ceiling concentration of 200 ppm as determined by a sampling period of 10 minutes.

INDUSTRIAL HYGIENE SURVEY
at
IOWA POWER AND LIGHT COMPANY
Council Bluffs Power Station
Council Bluffs, Iowa

October 5, 1982

SUBMITTED BY:

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety and Health Division
Atlanta, Georgia

Project No. A-3312

PART C

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

Iowa Power and Light Company retained the Georgia Tech Engineering Experiment Station to conduct an Industrial Hygiene Survey of it's Council Bluffs Power Station. The purpose of the survey was to measure employee exposure to selected potentially harmful chemical and physical agents. A total of 74 samples were collected and analyzed for a total of 16 different agents. This included the collection and analysis of samples for asbestos, noise, morpholine, nitrogen dioxide, carbon monoxide, sulfur dioxide, total nuisance dust, iron oxide, chromium, nickel zinc oxide, mangenese, lead, total respirable dust, welding fume, crystalline silica, and coal dust.

This report presents the results of the industrial hygiene survey, a discussion of the findings, and 20 recommendations based on the survey results. The results indicate a general improvement in hygiene practices resulting in reduced occupational exposure to selected chemical and physical agents. Most notably, coal dust and water treatment chemicals. The majority of the recommendations concern asbestos at units #1 and #2. A revision of the current Iowa Power asbestos program and its enforcement should reduce the risk of employee exposure to this compound. Other recommendations presented addresss conditions or procedures which have been previously addressed, but which need additional emphasis.

II. INTRODUCTION

Iowa Power and Light Company retained the Georgia Tech Research Institute to conduct an industrial hygiene survey of its Council Bluffs Power Station (CPS). The purpose of the survey was to measure employee exposure to selected chemical and physical agents. The survey was conducted on August 4-6, 1982 by Mr. William M. Ewing of Georgia Tech and Mr. Tom Shifflet of Iowa Power and Light. The survey included sampling for total nuisance dust, total respirable dust (coal dust), crystalline silica, asbestos, welding fume (metals), sulfur dioxide, carbon monoxide, nitrogen dioxide, morpholine, lead, and noise.

The following report includes a discussion of the results and recommendations based on the laboratory analysis of collected samples and observations of work practices and procedures. The results of air sampling are included in Appendix A. Noise measurements are compiled in Appendix B. The results of bulk and wipe sampling are included in Appendix C. Appendix D summarizes the sampling and analytical methods employed for this project. A brief discussion of the toxicity of contaminants monitored is included in Appendix E.

Each of the three days, the weather was partly cloudy or overcast with high temperatures in the low 80s. On August 4, 1982 Unit #1 was off-line until approximately noon. During the remainder of the day and during the following two days all three units were operating. The stacker-reclaimer was not operating on August 5 and 6. One train load of coal was unloaded using the rotary dumper on each of the three days. Figure I is a sketch of the facility depicting the locations of the units and coal handling system.

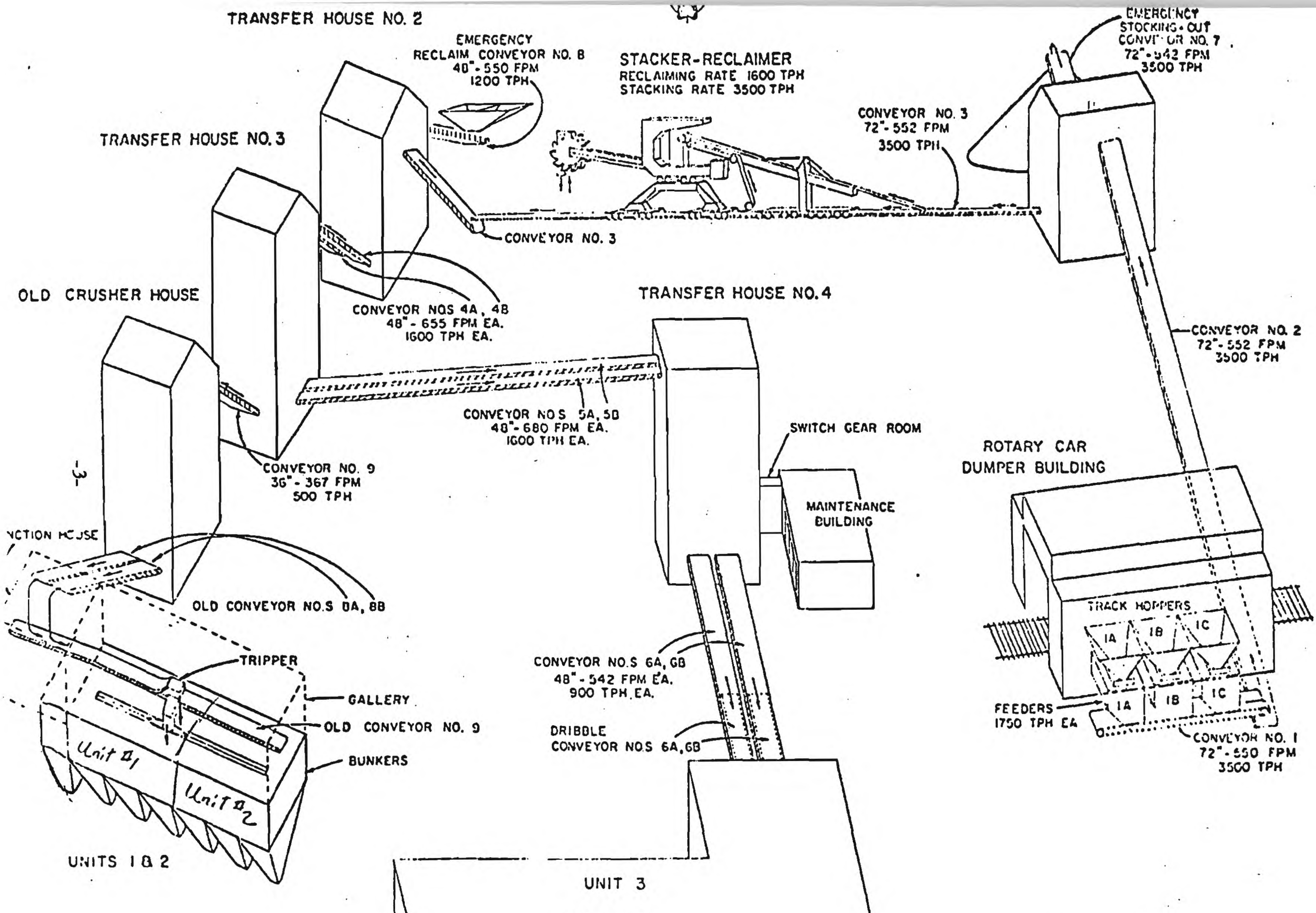

TRANSFER HOUSE NO. 2
EMERGENCY
RECLAIM CONVEYOR NO. 8
48"-550 FPM
1200 TPH
STACKER-RECLAIMER
RECLAIMING RATE 1600 TPH
STACKING RATE 3500 TPH
EMERGENCY
STOCKING-OUT
CONVEYOR NO. 7
72"-542 FPM
3500 TPH
TRANSFER HOUSE NO. 3
CONVEYOR NO. 3
72"-552 FPM
3500 TPH
CONVEYOR NO. 3
OLD CRUSHER HOUSE
CONVEYOR NOS 4A, 4B
48"-655 FPM EA.
1600 TPH EA.
TRANSFER HOUSE NO. 4
CONVEYOR NO. 2
72"-552 FPM
3500 TPH
CONVEYOR NO.S 5A, 5B
48"-680 FPM EA.
1600 TPH EA.
SWITCH GEAR ROOM
ROTARY CAR
DUMPER BUILDING
CONVEYOR NO. 9
36"-367 FPM
500 TPH
MAINTENANCE
BUILDING
OLD CONVEYOR NO.S 8A, 8B
TRACK HOPPERS
1A
1B
1C
TRIPPER
GALLERY
OLD CONVEYOR NO. 9
BUNKERS
Unit #1
Unit #2
CONVEYOR NO.S 6A, 6B
48"-542 FPM EA.
900 TPH EA.
DRIBBLE
CONVEYOR NO.S 6A, 6B
FEEDERS
1750 TPH EA
CONVEYOR NO. 1
72"-550 FPM
3500 TPH
UNITS 1 & 2
UNIT 3

Figure 1

III. DISCUSSION AND RECOMMENDATIONS

A. Noise

Before discussing the noise survey results, the OSHA standard will be reviewed. Recent revisions to the existing OSHA noise standard (1910.95) established an "action level" of 85 dBA. Briefly, if workers are exposed at or above the "action level", as an 8-hour time-weighted average (TWA), employers must now provide hearing protection and institute exposure monitoring, audiometric testing, and training.

The new amendment to the OSHA Noise standard actually requires that two noise level exposures be determined. One is an "action level" of 85 dBA and the other is a 90 dBA level. Both of these levels are time-weighted averages over an eight-hour work shift. However, the range of noise levels used to make the two determinations are different. For the "action level" of 85 dBA, all nosie impulses between 80 and 130 dBA are included in the calculation. For the 90 dBA permissible exposure level, only those noise impulses between 90 and 130 dBA are included in calculation. Consequently, the employee exposure results determined by the "action level" measurement criteria should be a higher value than the employee exposure results determined by the 90 dBA permissible exposure level criteria. This is because of the fact that any readings between 80 and 89 are included in the "action level" calculation but the readings would simply represent zero noise levels when calculating the PEL and would therefore lower the average value.

Major hearing loss studies show 85 dBA as the level where the risk of hearing impairment becomes fairly significant. While exposures to 80 dBA indicate a 0 to 5% risk, exposures at 85 dBA indicate a 10 to 15% risk of hearing impairment. At 90 dBA, this risk jumps to 21 to 29%.

The amendment set a date of February 22, 1982, for all employers to have completed initial monitoring to determine if workers are exposed to TWA noise levels at or above 85 dBA. Actions are required of an employer, depending upon the results of noise monitoring, as follows.

(1) If the 8-hour, TWA exposures are below 85 dBA no action is required.

(2) If the 8-hour, TWA exposures are at or above 85 dBA the employer is required to: provide hearing protection (use is optional unless significant threshold shifts in hearing are measured); provide initial fitting of protectors and employee training; provide annual audiometric testing for all potentially exposed employees; and complete baseline audiograms.

(3) If the 8-hour, TWA exposures are at or above 90 dBA the employer is required to: determine and implement feasibile engineering and/or administrative controls; ensure that hearing protection is worn; provide initial fitting of protectors, train employees in use and ensure that protectors reduce exposures to below 90 dBA; provide annual audiometric testing for all potentially exposed employees; retain records of monitoring and audiograms for each worker for the duration of employment; and ensure that the baseline audiograms are completed.

Twenty-six noise dosimetry measurements were taken at the Council Bluffs Power Station (CPS) to measure employee exposure to continuous A-weighted noise. One of the measurements, although included in Appendix B, should be considered invalid since it was suspected that the measuring device may have been tampered with during sampling. This measurement has been labeled such in Table B-4. Accordingly, the following discussion and any conclusions and recommendations are based on 25 samples believed to be valid representations of employee exposure to noise.

The 25 measurements were used to determine employee exposure in relation to the IOSH action level of 85 dBA for eight hours. In addition, 15 of these measurements were used to determine compliance with the IOSH permissible exposure limit (PEL) of 90 dBA for eight hours. It is important to recognize that the criteria for measuring compliance with the 90 dBA PEL is different from the criteria for measuring compliance with the 85 dBA action level. For this reason the numbers cannot be interchanged but rather, must be viewed and discussed separately.

Of the 25 measurements used to determine if employee exposures exceeded the 85 dBA action level, 11 or 44 percent exceeded 85 dBA. This is a slight reduction from the 60 percent over the action level in the 1981 survey. It should be noted that 21 of 25 measurements exceeded 80 dBA. This represents 84 percent of the population sampled. Table I below presents a frequency distribution of noise dosimetry measurements with the 85 dBA action level.

TABLE I

SUMMARY OF NOISE DOSIMETRY MEASUREMENTS

Equivalent Exposure Range (dBA)	Number of Samples	%
$\geq$85	11	44
$\geq$80 but <85	10	40
$\geq$75 but <80	1	4
$\geq$70 but <75	3	12
Total	25	100

Ten dosimetry measurements were taken to determine compliance with the 90 dBA ISHA PEL. Although none of these measurements exceeded 90 dBA, one approached the 90 dBA limit (89.5 dBA). This measurement was taken for the D-9 Cat Operator. It should be noted that the coal handlers operating the coal moving equipment rotate jobs so that one employee does not operate the D-9 Cat every day.

A hearing conservation program is currently in effect at the Council Bluffs Power Station. Although most employees were observed wearing hearing protectors, several did not when working in areas requiring protection.

> RECOMMENDATION #1: The wearing of hearing protection by employees working in high noise areas should be strictly enforced.

It was noted that contractor personel, not Iowa Power employees, often do not observe the policy regarding the wearing of hearing protectors. These people are often working in high noise areas in close proximity to

Iowa Power employees. Accordingly, the contractor employees set a poor example and weaken the effect of the Iowa Power Hearing Conservation Program.

> RECOMMENDATION #2: Consideration should be given to enforcement of the hearing protection requirement in high noise areas for all persons including contractor personnel.

B. Coal Dust and Crystalline Silica

A total of 21 personal and one area air samples were collected to measure employee exposure to dusts. Ten personal samples were collected and analyzed for total respirable dust. The concentrations of total respirable dust ranged from 0.31 to 1.84 milligrams per cubic meter of air sampled (mg/m^3). All samples were below the IOSH permissible exposure limit (PEL) of 2.4 mg/m^3, determined as 8-hour, time-weighted averages (TWA).

All 10 respirable dust samples were collected for employees performing coal handling duties. It is interesting to note that 8 of the samples were below 0.51 mg/m^3 (8-hour, TWA). Each of these samples were taken for employees working with the heavy coal moving equipment. The two highest values, 1.03 and 1.84 mg/m^3, were collected for employees working in the old crusher house and the Units #1 and #2 tripper floor, respectively. The source of coal dust exposure at the tripper floor is coal being dumped into the silos. This employee must stand directly above the location where the coal is dumped to watch the level of coal in the silo.

The primary source of exposure for the crusher house employee was during cleaning after the coal has been run. The new local exhaust system in the old crusher house appears to have reduced coal dust exposures at this location.

Three of the respirable dust samples were analyzed for crystalline silica (quartz). The results indicated all exposures were less than one-half of the calculated IOSH PEL for crystalline silica. These results are presented in Appendix A, Table A-3.

A total of 12 samples were collected and analyzed for total dust. For the 11 personal samples, the concentration of total dust ranged from 0.12 to 6.41 mg/m^3, determined as 8-hour TWAs. Ten of the these sample results were below 1.2 mg/m^3. One sample, collected for an employee working in the Units #1 and #2 tripper floor, indicated the 6.41 mg/m^3 concentration. None of the samples exceeded the IOSH PEL for total dust of 15 mg/m^3, or the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 10 mg/m^3, determined as 8-hour, TWAs.

It should be noted that although most of the total dust samples were collected for coal handlers, several samples represent exposures of mechanics, labors, and coal handlers hauling fly ash. The results of the individual samples are compiled in Appendix A, Tables A-1 and A-2.

One area sample was collected on the base level of Unit #3 directly below the vacuum exhaust. This sample was collected when the vacuum was in use to estimate the potential for employee exposure resulting from the exhaust. The sample indicated 0.42 mg/m^3 total dust. This indicates that the exhaust is diluted enough by the outside air so that the concentraton is low where employees might be working.

C. Asbestos

Both bulk and air samples were collected at selected locations at the Council Bluffs Power Station. These results are compiled in Appendix C. Sampling was concentrated at Units #1 and #2 since these were the only areas of the facility where asbestos had been found in the past.
Four bulk samples were collected at Units #1 and #2. Asbestos was detected in all four samples, ranging from 25 to 40 percent (by volume). Both the chrysotile and amosite forms were identified. Two of the samples were pipe insulation, one sample was troweled-on fireproofing located on the 7th level of Unit #2, and one was a sample from the steam tank located on the roof (7th level) of Unit #1.

Observations revealed pieces of pipe insulation and fireproofing in the gratings, on surfaces, and on the floors throughout Units #1 and #2. Large amounts of settled dust were also visible throughout. Two samples of settled dust were collected and analyzed for asbestos by polarized light microscopy (PLM). The results of these analyses revealed the samples to contain 50 and 80 percent asbestos (both amosite and chrysotile forms present). This dust can be easily disturbed by employees performing routine duties and presents a potential hazard.

RECOMMENDATION #3: Housekeeping practices in Units #1 and #2 should be improved to include the prompt removal of settled dust from surfaces to reduce the potential for asbestos exposure. The dust should be removed using a high efficiency particulate absolute (HEPA) filtered vacuum to minimize the re-entrainment of asbestos-containing dust.

Asbestos-containing insulation is routinely removed from pipes and tanks by Iowa Power and contractor personnel. Although Iowa Power has specific procedures to be followed, these are not strictly enforced. During the time of the survey several pipes were stripped of asbestos-containing insulation with no precautions taken to protect the employees performing the work or other persons in the area.

RECOMMENDATION #4: One person at the facility should be designated as the asbestos coordinator and have responsiblity for ensuring that all proper precautions are followed when asbestos containing materials are disturbed.

RECOMMENDATION #5: The asbestos coordinator should be informed of any work involving asbestos at least several days prior to the work. This would include all contractors as well.

Recent evidence has determined that the current OSHA asbestos standard does not offer adequate protection to employees against the carcinogenic effects of asbestos exposure. This has been amplified by the U. S. Environmental Protection Agency's (EPA) regulation regarding asbestos in schools. The current Iowa Power Asbestos Program was reviewed and should be updated. The following recommendations should be used as guidance for this update.

RECOMMENDATION #6: Employees should be thoroughly familiar with the hazards of asbestos and methods of insulation removal which will minimize airborne emissions of asbestos fibers. Consideration should be given to requiring the use of the insulation injection technique developed by the U. S. Navy. This method has been shown to greatly reduce fiber emissions by injecting pipe insulation with a wetting agent (ethylene glycol and water) prior to removal.

RECOMMENDTION #7: The work area should be sealed from all other areas so that fibers generated during the removal operations will not be dispersed throughout the facility where unprotected employees are working. A polyethylene film enclosure works well for this.

RECOMMENDATION #8: A recent interpretation by OSHA of the asbestos standard requires that supplied-air (Type C) respirators be used during pipe demolition (or insulation removal) until air samples indicate that a respirator offering less protection is adequate.

RECOMMENDATION #9: Plastic film (at least 6 mil) should cover the grating beneath the work area to prevent asbestos-containing debris from falling through to other areas.

RECOMMENDATION #10: All asbestos-containing waste should be bagged while wet. The bag should be labeled and placed in a fiberboard drum for transporation to the disposal site. The drums may be reused.

RECOMMENDATION #11: Employees should be instructed to vacuum dust off their persons with a HEPA filtered vacuum after removing their protective garments. They should be instructed to shower immediately after vaccuming. This will minimize the risk of taking asbestos into the employee's home.

RECOMMENDATION #12: All other portions of the existing asbestos protection program should be enforced, including requirements for the posting of warning signs and labeling the waste in accordance with OSHA and EPA regulations.

A program to identify and monitor asbestos exposures should be instituted with all records maintained by the asbestos coordinator or other responsible employee. It is important to know what type of asbestos (amosite, chrysotile, etc.) is encountered in order that proper procedures will be followed. It should also be noted that not all types of insulation contain asbestos. A method commonly in use by many industries is to color code pipes and other insulated objects so that supervisors are aware of which insulations contain asbestos.

One bulk sample was collected from a pipe in Unit #3. This sample was found to contain 30% cellulose with no asbestos forms detected. It was not anticipated that asbestos would be present in samples.

Five area air samples were collected at various locations at Units #1 and #2. The results indicated fiber concentrations ranging from less than 0.01 to 0.06 fibers* per cubic centimeter of air sampled (fibers*/cc). The value did not exceed the IOSH PEL of 2 fibers*/cc or the "action level" of 0.1 fibers*/cc. However, recent evidence indicates that small quantities of asbestos fibers may pose a threat to individuals exposed. Further, the fiber counting method normally used does not distinguish between asbestos fibers and other airborne fibers*. Also, the method does not permit the identification of fibers shorter than 5 micrometers in length. Accordingly, electron microscopy analyses should be considered during future sampling efforts.

*greater than 5 micrometers in length

D. Miscellaneous

1. Leaded Paint

Three samples of paint chips were collected at Units #1 and #2 and analyzed for lead and chromium. It was noted that the paint on the support beams and boiler (outside) has begun to deteriorate. In several spots the paint had been chipped away and sanded. Both lead and chromium were found in all three samples collected. One sample, taken from Unit 1 (orange/green paint) was found to contain 31 percent lead and 7.2 percent chromium. Each of these metals are recognized as highly toxic. The potential for employee exposure to lead and chromium exists when sanding these surfaces and during welding on these painted surfaces.

RECOMMENDATION #13: Respiratory protection should be provided for any employees engaged in the chipping, sanding, or welding on painted surfaces until air sampling has determined the probable range of exposures during these activities.

RECOMMENDATION #14: Air samples should be collected in the employee's breathing zone during welding, sanding, and chipping leaded paint to determine exposure to inorganic lead, total chromium, and hexavalent chromium.

2. Acid Gases

During the survey it was noted that an expansion joint had ruptured at a Unit #3 ID fan allowing stack gases to escape. High concentrations of sulfur dioxide were measured at the point of emission although several feet away the concentration was acceptable due to dilution. However, the repair was accomplished while Unit #3 was operating requiring the employee to work at the point of gas emission. An interview with supervisory personnel indicated that breaks in the rubber expansion joints are common and that no special precautions are taken during repair.

> <u>RECOMMENDATION #15:</u> Employees assigned to repair an expansion joint when a unit is operating should be supplied with respiratory protection to protect against accute effects of sulfur and nitrogen oxide emissions during the repair work.

3. Water Treatment Chemicals

An inspection was made of the water treatment chemical storage and dispensing sites. Each site was found to be relatively clean, and protective equipment (showers, eyewashes, clothing) in working order . Each area had appropriate warning signs which were clearly visible. All employees performing activities at the water treatment stations were observed wearing the proper protection equipment (apron, gloves, goggles).

Two wipe samples were taken at the Unit #3 and Units #1 and #2 dispensing stations, respectively. These samples were analyzed for morpholine. The sample from the Unit #3 dispensing station valve and timer knobs indicated 0.21 mg morpholine. The sample from the Units #1 and #2 dispensing station valve and timer knobs indicated 0.19 mg morpholine. The limit of detection for this analysis was 0.005 mg. These samples indicate that although these knobs may appear clean to the eye, they still are contaminated with water treatment chemicals. Accordingly, the protective equipment including gloves, should continue to be worn by employees working with the treatment chemicals.

It was noted that hydrazine is no longer used at this facility. A substitute chemical, NALCO Elimin-Ox, is being used. This chemical, an aqueous amine, is less toxic than hydrazine (according to a NALCO representative). Due to proprietory information regarding this product, information regarding its content was not made available to us. However, the material safety data sheet recommends eye and skin protection. Based on this information, the current working procedures for handling water treatment chemicals should be satisfactory for this chemical.

4. Units #1 and #2 Maintenance Shop

A walk-through survey was conducted of the Units #1 and #2 Maintenance Shop located directly west of Units #1 and #2. Housekeeping and hygiene facilities (showers and locker room) located in this area appeared neat and clean. The degreaser used in the Maintenance Shop was found to be in good repair.

The lubricating oil in the lathe and hacksaw is rarely changed. This allows for a build-up of bacteria in the oil run-off pans. The risk of dermatitis is increased when employees reach into these pans for parts or to clean out filings without protective gloves. Interviews with workers indicated that occasional dermatitis is a problem.

> RECOMMENDATION #16: Lubricating oils should be changed periodically to prevent the build-up of bacteria. Employees should be provided with gloves when they immerse their hands into the oil pans.

The hood above the welding table is exhausted two feet above an open window to the maintenance shop. The exhaust faces down and and the maintenance shop is under a negative pressure with respect to the outside air. The combination of these two factors forces the exhausted air to be drawn into the maintenance shop and the worker's breathing zone.

> RECOMMENDATION #17: The window below the welding table exhaust duct should be repaired and remain closed whenever the exhaust is operating.

5. Screen House

The screen house for Unit #3 has been designated a high noise area and signs are posted on the outside of the doors stating that hearing protection must be worn. However, during the warmer months of the year these doors remain propped open so that the warning signs are not visible. Another sign on the inside of each door or immediately inside the building would alleviate this problem.

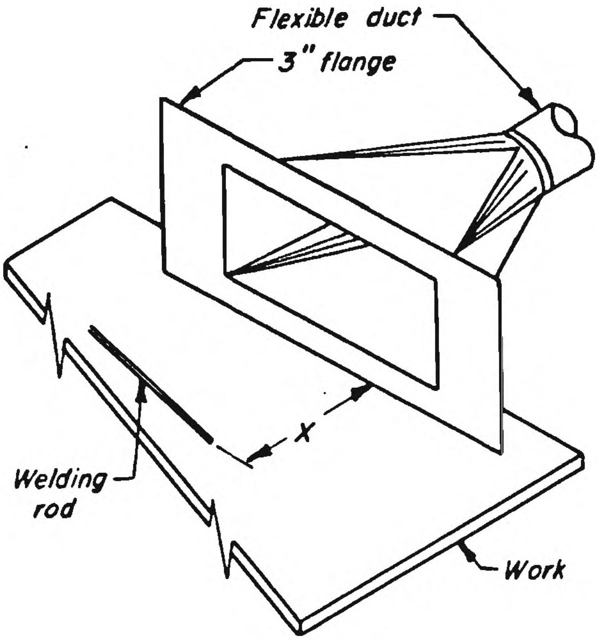
6. Unit #3 Maintenance Shop

A walk-through survey of the Unit #3 maintenance shop revealed housekeeping to be adequate throughout. The degreaser and shot-blast booth were found to be in good repair.

Recently, a hood was constructed in the welding area to remove welding fume. This hood is a suspended box type located directly above the welding table. Personal air samples were collected on two days to determine if the hood was controlling exposures adequately. The two samples indicated welding fume concentrations of 27 and 74 mg/m^3, respectively. The samples further indicated iron oxide, zinc oxide, and lead concentrations well in excess of their respective IOSH PELs. It should be noted that the samples were partial period samples and are not indicative of the employee's 8-hour, TWA exposure since they were only welding part of the day. Based on this information the exiting local exhaust system does not adequately reduce welding fume and associated metal concentrations below applicable limits.

There are two reasons for the hood not providing sufficient control for the hazard. The primary reason is no significant (not measurable, less than 20 ft/min) capture velocity at the source. Since most welding must be done on the edge of the table or on the floor, the hood tends to slowly draw the fume through the employees breathing zone.

> RECOMMENDATION #18: Remove the existing hood and replace it with a portable or flexible duct exhaust as depicted in Figure II. It may be possible to retain the existing fan. Such a system would allow the welder to place the local exhaust pick-up very close to the source of the fume.



PORTABLE EXHAUST

X, inches	Plain duct cfm	Flange or cone cfm
up to 6	335	250
6 - 9	755	560
9 - 12	1335	1000

Face velocity = 1500 fpm
Duct velocity = 3000 fpm minimum
Plain duct entry loss = 0.93 duct VP
Flange or cone entry loss = 0.25 duct V

Figure II

7. Other

A walk-through survey of all three units and the coal handling system revealed several areas where illumination may not be adequate. This was especially evident on the upper levels of Unit #3.

> <u>RECOMMENDATION #19:</u> Lighting equipment should be promptly repaired and light bulbs replaced when necessary to provide proper illumination in accordance with the ANSI Industrial Lighting Standard (ANSI/A11.1).

> <u>RECOMMENDATION #20:</u> Illumination levels should be determined throughout the facility to assure that existing lighting is adequate. Improper lighting can result in increased safety hazards (tripping, etc.).

Due to the relatively cool temperatures (low 80s) and overcast conditions on the 3 days of the survey, heat stress measurements were not attempted. These measurements would not have been indicative of work performed during hot days.

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APPENDIX A

Results of Air Sampling

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Council Bluffs Power Station
Council Bluffs, Iowa

Materials Total Respirable Dust (TRD)
Total Dust (TD)

Date 1982	Sample Number	Description	Sampling Period Start	Sampling Period Stop	Sample Volume (Liters)	Sample Time (Min.)	Concentration TRD (mg/m^3)	Concentration TD (mg/m^3)
8/4	PVC-26	Jim Scott, Coal Handler, Hauling Fly Ash	0719	1436	743	437	0.51	-
8/4	M-26	Jake Brazeal, Coal Handler, Dumper Building & Fly Ash Hauling	0721	1436	870	435	-	0.29
8/4	PVC-48	Ken Smith, Coal Handler, Stacker Reclaimer Operator	0725	1434	729	429	0.34	-
8/4	M-27	Henry Peterson, Coal Handler, Units 1 & 2 Tripper Floor	1500	1750	340	170	-	6.41
8/4	M-16	Jeff Wilke, Coal Handler, Units 1 & 2 Crusher House	1500	1750	340	170	-	1.17
8/5	M-18	Steve Duff, Coal Handler, Scraper Operator	0715	1430	870	435	-	0.69
8/5	PVC-18	Jim Scott, Coal Handler, Roving (Mostly in Shop)	0717	1430	736	433	0.40	-
8/5	PVC-44	Jake Brazeal, Coal Handler, D-9 CAT Operator	0719	1430	733	431	0.31	-
8/5	M-20	Paul Hanshaw, Coal Handler, 380 Michigan Operator	0721	1430	858	429	-	1.14
8/6	M-22	Doug Feller, Coal Handler, Raygo Operator	0727	1435	856	428	-	0.44
8/6	M-24	Jim Scott, Hauling Fly Ash, Coal Handler	0734	1435	842	421	-	0.49
8/4	M-28	John Poteet, Units 1 & 2 Auxiliary Operator	0704	1347	806	403	-	0.37
8/5	M-30	Walter Neal, Units 1 & 2 Auxiliary Equipment Operator	0713	1347	788	394	-	0.33
8/5	PVC-23	Terry Bressman, Units 1 & 2 Equipment Operator	0730	1357	658	387	0.38	-

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Council Bluffs Power Station
Council Bluffs, Iowa

Materials Total Respirable Dust (TRD)
Total Dust (TD)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			TRD (mg/m^3)	TD (mg/m^3)
8/6	PVC-19	Jerry Sabatka, Unit 3 Equipment Operator	0650	1400	731	430	0.27	-
8/4	M-17	Harry Haase, Mechanic, Changing Coal Impeller	0824	1520	832	416	-	0.55
8/4	PVC-3	Dennis Schupp, Mechanic, Changing Coal Impeller	0826	1520	704	414	0.31	-
8/5	M-12	Susan Driscoll, Laborer, Unit 3, Steam Cleaning Coal Mills	0756	1524	896	448	-	Filter Damaged by Water
8/5	M-35	Mark Harrison, Mechanic, Units 1 & 2	0842	1510	776	388	-	0.12
8/4	M-34	Area Sample, Unit 3, at Coal Mill 301, Below Vacuum Exhaust	0851	1324	546	273	-	0.42

Table A-3

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant: Council Bluffs Power Station, Council Bluffs, Iowa

Material: Total Respirable Dust (TRD), Crystalline Silica (SiO_2)

Date 1982	Sample Number	Description	Sampling Period*		Total Sample Weight (mg)	Sample Volume (Liters)	Concentration			OSHA & ACGIH** Standard $\frac{10\ mg/m^3}{\%\ SiO_2+2}$
			Start	Stop			TRD (mg/m^3)	SiO_2 (mg/m^3)	SiO_2 (%)	
8/4	PVC-13	H. Peterson, Coal Handler, Units #1 & #2 Tripper Floor	1500	1750	0.531	289	1.84	0.007	0.4	4.2
8/4	PVC-42	J. Wilke, Coal Handler, Units #1 & #2 Crusher House	1500	1750	0.298	289	1.03	<0.007	<0.7	5.0
8/4	PVC-41	J. Braziel, Coal Handler, 380 Michigan Operator	0722	1435	0.293	736	0.40	<0.003	<0.7	5.0

Table A-4

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Council Bluffs Power Station

Council Bluffs, Iowa

Materials Total Welding Fume (WF), Iron Oxide (Fe_2O_3), Chromium (Cr), Nickel (Ni), Zinc Oxide (ZnO), Manganese (Mn), Lead (Pb) (All Values Blank Corrected)

Date 1982	Sample Number	Description	Sampling Period		Concentrations						
			Start	Stop	WF (mg/m^3)	Fe_2O_3 (mg/m^3)	Cr (mg/m^3)	Ni (mg/m^3)	ZnO (mg/m^3)	Mn (mg/m^3)	Pb (mg/m^3)
8/4	M-23	Mike O'Conner, Welding At New Hood In Shop Of Unit #3*	1232	1251	74.	32.	0.476	0.074	25.	1.95	0.184
8/4	M-32	D. Hendrix, Mechanic, Welding Iron In Shop Of Unit #3.	1236	1346	27.	18.	0.005	0.006	0.006	1.01	0.014

*Welded continuously the following: 2 rods stainless, 2 rods steel, also cut galvinized grating and Esterlite™ pipe.

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Council Bluffs Power Station
Council Bluffs, Iowa

Materials Fibers Greater Than 5 Micrometers In Length

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			Fibers Per Filter	Fibers Per cc Air
8/4	ASB-01	Area Sample, Control Room Level, Firing Face of Unit #1	1043	1324	322	161	8,000	0.03
8/4	ASB-02	Area Sample, Beneath Turbine of Unit #2 (Minor Pipe Work)	1049	1325	312	156	18,000	0.06
8/6	ASB-03	Area Sample, Bottom Level, on Top of Unit #1 Oil Filter	0826	1428	724	362	6,000	0.01
8/6	ASB-04	Area Sample, Outside, Unit 1, East Side of Boiler, 6th Level	0840	1432	704	352	11,000	0.02
8/6	ASB-05	Area Sample, Unit #2 Fan Room, Bottom Level	0830	1430	720	360	3,000	0.01

Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Council Bluffs Power Station
Council Bluffs, Iowa

Materials Carbon Monoxide (CO), Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2)

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop					
8/4	SO_2-1	Area Sample, Under ID Fan #301, Leak in Duct	0859	1308	4.98	249	-	0.60	-
8/4	CO-1	Area Sample, Under ID Fan #301, Leak in Duct	0859	1308	4.98	249	<2.0	-	-
8/4	NO_2-1	Area Sample, Under ID Fan #301, Leak in Duct	0859	1308	4.98	249	-	-	<0.4
8/6	NO_2-2	Steve Duff, Coal Handler, D-9 CAT Operator	0725	1435	8.60	430	-	-	<0.2
8/6	NO_2-3	Paul Henshaw, Coal Handler, Scraper Operator	0725	1435	8.60	430	-	-	<0.2

APPENDIX B

Results of Noise Dosimetry Measurements

Table B-1

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company Iowa Power - CBPS

Date 8/4/82

Test by William Ewing

Operating Conditions Unit #1: Off-Line; Unit #2: On-Line; Unit #3: On-Line

Dosimeter Model No. N/A S/N

Calibrator Model No. N/A S/N

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
2890	-	John Poteet	1348	412	84.5	81.8
		Unit 1 & 2, Auxiliary Operator	0656			
2751	-	Larry Diamond	1347	400	74.3	71.0
		Unit 1 & 2, Equipment Operator	0707			
2885	-	Steve Duff (Coal Handler)	1435	380	79.4	75.8
		Dumper Building	0715			
2891	-	Bill Fletcher	1348	361	81.9	77.8
		Unit 1 & 2, Equipment Operator	0747			
2750	-	Dennis Schupp (Mechanic)	1520	413	88.0	86.3
		Changing Coal Impeller	0827			
9710	4281	Walter Neal	1336	397	81.5	-
		Unit 1 & 2, Auxiliary Operator	0659			
9700	4513	Ken Smith (Coal Handler)	1434	431	73.4	-
		Stacker - Reclaimer	0723			
9693	4284	Harry Haase (Mechanic)	1520	413	81.7	-
		Changing Coal Impeller	0826			

Table B-2

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company Iowa Power - CBPS

Date 8/5/82

Test by William Ewing

Dosimeter Model No. N/A S/N

Operating Conditions All Units Operating

Calibrator Model No. N/A S/N

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period		Equivalent Sound Level (8 hr. - TWA)	
			Stop/ Start	Total Time (min.)	Action Level (dBA)	Permissible Exp. Limit (dBA)
2890	-	Steve Duff (Coal Handler)	1430	434	84.2	77.0
		Scraper	0716			
2751	-	Jim Scott (Coal Handler)	1430	432	74.0	72.2
		Roving	0718			
2885	-	Jake Brazeal (Coal Handler)	1430	430	90.5	89.5
		D-9 Cat Operator	0720			
2750	-	Paul Hanshaw (Coal Handler)	1430	428	89.2	88.3
		380 Michigan Operator	0722			
2891	-	Bob Carey - Laborer, Steam Cleaning	1526	452	89.5	88.8
		Coal Mill (Unit 1 & 2)	0754			
9710	4281	Jerry Sabatka	1500	415	83.0	-
		Unit 3, Equipment Operator	0805			
9711	1774	Dennis Hendrix (Mechanic)	1510	403	84.1	-
		Units 1 & 2	0827			
9693	4284	Ron Boseck	1526	448	85.8	-
		Unit 3, Equipment Operator	0758			
9700	4513	Larry Diamond	1351	383	86.1	-
		Unit 1 & 2, Equipment Operator	0728			

Table B-3

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company: Iowa Power - CBPS

Date: 8/5/82

Test by: William Ewing

Dosimeter Model No.: N/A S/N:

Operating Conditions: All Units Operating

Calibrator Model No.: N/A S/N:

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/ Start	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
9690	2165	Mark Harrison, Mechanic	1510	386	84.2	-
		Unit 1 & 2	0844			

Table B-4

Georgia Institute of Technology
Engineering Experiment Station

NOISE EXPOSURE DATA SHEET

Company: Iowa Power - CBPS

Date: 8/6/82

Test by: William Ewing

Dosimeter Model No.: N/A S/N:

Operating Conditions: All Units Operating

Calibrator Model No.: N/A S/N:

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/ Start	Exposure Period: Total Time (min.)	Equivalent Sound Level (8 hr. - TWA): Action Level (dBA)	Equivalent Sound Level (8 hr. - TWA): Permissible Exp. Limit (dBA)
2751		Jake Braziel (Coal Handler)	1435	433	98.2*	98.0*
		380 Michigan Operator	0722			
2885		Steve Duff (Coal Handler)	1435	431	85.2	73.7
		D-9 Cat Operator	0724			
2890		Paul Henshaw (Coal Handler)	1435	430	83.8	66.1
		Scraper Operator	0725			
2891		Doug Feller (Coal Handler)	1435	425	86.1	84.6
		Raygo Operator	0730			
2750		Jim Scott (Coal Handler)	1435	422	81.9	78.5
		Hauling Fly Ash	0733			
9710	4281	Sue Driscoll (Laborer)	1505	431	89.7	-
		Cleaning Coal Mills (Unit 3)	0754			
9690	2165	Dennis Seivers (Mechanic)	1502	424	88.1	-
		Unit 3, Main Slab	0758			
9711	1774	John Hood (Mechanic), 2 hours in	1502	411	87.7	-
		Screen House, 6 hours at Condensor	0811			

APPENDIX C

Results of Bulk Sample Analyses

RESULTS OF ASBESTOS ANALYSIS OF
BULK SAMPLES COLLECTED AT
IOWA POWER AND LIGHT COMPANY
COUNCIL BLUFFS POWER STATION

Sample Number	Sample Description	Analytical Results
Bulk A	Unit 1 & 2 office building, 3rd level hallway, ceiling material	10% cellulose in particulate
Bulk B	Unit 2, pipe lagging removed on 8/6/82 from outside boiler, next to soot blower IK-9	25% amosite asbestos in particulate
Bulk C	Unit 1, 7th level steam tank (on roof)	40% amosite asbestos in particulate
Bulk D	Unit 2, 7th level, troweled on fireproofing south of boiler (ceiling)	20% chrysotile and 20% amosite asbestos in particulate
Bulk E	Unit 1, 6th level (outside), pipe lagging removed on 8/6/82, east side of boiler	40% amosite asbestos in particulate
Bulk F	Unit 2, base level, below turbine 2, top of oil filter, settled dust from removed work done several months prior to sampling	30% chrysotile and 20% amosite in particulate
Bulk G	Unit 1, settled dust, turbine level, firing face of boiler 1, dust on floor	40% chrysotile and 40% amosite in particulate
Bulk H	Unit 3, mezzanine level, pipe lagging being removed by Babcock & Wilcox (contractors)	30% cellulose in particulate

RESULTS OF LEAD ANALYSES OF
PAINT SAMPLES COLLECTED AT
IOWA POWER AND LIGHT COMPANY
COUNCIL BLUFFS POWER STATION

Sample Description	Analytical Results Lead (Pb)	Chromium (Cr)
Paint-1, orange & green from unit 1 structural supports (outside).	31%	7.2%
Paint-3, red & green from unit 2 structural supports (outside).	0.50%	2.1%
Paint-2, off-white, from unit 1 boiler (outside).	0.47%	1.1%

RESULTS OF WIPE SAMPLE ANALYSES
FOR MORPHOLINE FROM
IOWA POWER AND LIGHT COMPANY
COUNCIL BLUFFS POWER STATION

Sample Description	Morpholine (mg)
Wipe-1, unit 3 chemicals area, from timer and pump knobs	0.21
Wipe-2, units 1 & 2 chemicals area, from timer and pump knobs	0.19
Limit of detection	0.005

APPENDIX D

Sampling and Analytical Methods

ASBESTOS (airborne)

Samples for the determination of airborne asbestos fibers were collected by drawing air at measured flowrates through open-face cassettes containing 37-millimeter diameter cellulose ester membrane filters (Millipore, Type AA) using battery-powered, portable pumps. After collection of each sample the cassette was covered and sealed immediately for transport to the laboratory.

Each sample was analyzed subsequently for asbestos fibers using the microscopic technique currently specified by the National Institute for Occupational Safety and Health (NIOSH). Briefly, the technique consisted of the following steps: a wedgeshaped sector of each filter was cut carefully from the sample and mounted on a standard microscope slide, using a high-viscosity solution of membrane filter material in a 1:1 mixture of diethyl oxalate and dimethyl phthalate to render the filter transparent. Asbestos fibers, defined as particules having aspect ratios (apparent length to width) of three or greater, which were observable on the surface of the filter were counted using a binocular microscope equipped with 10X eyepieces and a 40X objective with phase contrast illumination. Porton reticle fields, selected at random on the sample, were examined and fibers greater than five micrometers in length were counted until either of two conditions was satisfied:

1. A minimum of 100 fibers was counted in 20 or more fields.

2. A minimum of 100 fields was examined.

Results of the microscopic analyses were used in conjunction with field sampling data (measured flowrates and durations of sampling) to calculate the concentrations of airborne asbestos fibers corresponding to each sample in units of fibers greater than five micrometers in length per cubic centimeter of air (fibers 5um per cc).

CARBON MONOXIDE

Sampling for carbon monoxide (CO) was conducted by using the following two techniques.

Short-term area sampling (direct reading instantaneous) was performed either by drawing measured volumes of air through a length of stain detector tube via a hand-operated sampling pump, or by a direct-reading meter.

In the detector tube system, the CO indication is based upon the reduction of potassium palladosulfite impregnated silica gel giving a color change of yellow to brown in the presence of CO. The length of stain of the detector chemical is proportional to the CO concentration (in ppm) and must be matched to a chart corresponding to the number of pump strokes employed (1 full stroke = 100 cc) on the instruction sheet which accompanies the tubes.

The basic principle of operation of the direct reading meter involves drawing air (pre-cleansed to remove interferences) through an electrochemical sensor cell at a nominal flowrate of 700 cc/minute. The sensor cell is composed of a catalytically active sensing electrode (platinum), a counter electrode, a reference electrode and an aqueous sulfuric acid solution as the electrolyte. In the direct reading meter, the electrochemical process is carried out at a potential-controlled electrode. The current measured upon introduction of CO to the sensor cell is the result of the electro-oxidation of CO to carbon dioxide (CO_2) and is proportional to the partial pressure of CO in the sampled air.

METALS AND TOTAL DUST

Samples to be analyzed for metallic elements and total dust were collected by drawing air at measured flowrates through cassetted cellulose ester membrane filters using battery-powered, portable pumps.

The mass of particulate matter collected on each filter was determined gravimetrically in the laboratory as the difference between the tare weight of the filter and the weight of the filter after sampling and equilibration to balance room conditions.

For the analyses of metals, the filter matrices were destroyed by ashing with concentrated nitric acid, and the residues dissolved in either dilute hydrochloric acid or dilute nitric acid. The resultant solutions were aspirated into the flame of an atomic absorption spectrophotometer equipped with the appropriate hollow-cathode lamps. After scattered light corrections, the absorbances at the analytical wavelengths of the samples were compared to the absorbances to aqueous standard solutions containing known amounts of the metal analytes. Analytical results, which include any necessary corrections for blank and recovery determinations run in parallel with the analyses, were used in conjunction with the measured flowrates and sampling durations to calculate the concentrations of airborne analyte species, expressed in units of milligrams of analyte per cubic meter of air (mg/m^3).

NITROGEN DIOXIDE

Integrated, long-term sampling was performed by drawing air at measured flowrates (nominal 10-20 cm^3/min) through a color change detector tube by a battery-powered, portable pump.

In the detector tube sampling system, the indication is based on the reaction of nitrogen dioxide with diphenyl benzidine which provides a color change of yellow to dark blue-grey. The length of stain shown by the detector chemical is proportional to the nitrogen dioxide concentration which must be calculated in conjunction with the air volume sampled.

NOISE DOSIMETRY

Noise dosimetry studies of employee noise exposures were made using DuPont, Model D-376, Audio Dosimeters, set for a 90 dBA cutoff.

Sound levels reaching the employee were detected by a non-directional ceramic microphone worn on the shirt collar. This input is attenuated using the "A" weighting scale described in the American National Standards Institute S1.4-1971 "Type 2 Specification". If the microphone picks up any continuous sound over 115 dBA, it is recorded and stored for later inspection.

Next, noise below the cutoff level, 90 dBA, is removed on a continuous basis. The ratios of actual exposure to established limits at every sound level between 90 and 115 dBA are calculated and integrated with time to give the actual exposure during the workday as a percentage of that permitted by the regulations.

Data storage is accomplished by means of an electroplating reaction that occurs within an integrating memory cell. The information is stored in the cell until it is retrieved in a DuPont, Model R-225 readout instrument by reversing the electroplating reaction. The memory cell is automatically cleaned for reuse as the exposure information is retrieved.

Prior to use, the Audio Dosimeter battery is checked with an internal battery check and calibrated at two sound levels with a DuPont, Model C-114, calibrator.

RESPIRABLE DUST AND FREE SILICA

Samples to be analyzed for "respirable" dust and crystalline free silica were collected by using battery-powered, portable pumps to draw air at a nominal flowrate of 1.7 liters per minute through 37-millimeter diameter polycarbonate membrane filters, 0.8 micrometer pore size contained in cassettes preceded by 10-millimeter nylon cyclone particle size selectors.

The mass of particulate matter collected on each filter was determined gravimetrically as the difference between the weights of the filters before and after sampling, using a five-place analytical balance in a temperature-and-humidity controlled environment. The samples then were transferred into beakers containing small volumes of a surfactant solution (5% Triton X-100 in distilled water) and placed in an ultrasonic vibrator bath to dislodge particulate matter from the filter matrices. The resultant suspensions then were passed through 25-millimeter diameter polycarbonate membrane filters, 0.4 micrometer pore size, using vacuum filtration to achieve uniform sample deposits. After drying, the filters were placed on the rotating sample state of an X-ray diffractometer equipped with data control and data processor to provide both digital and graphic indication of detector responses. The masses of crystalline free silica (quartz, cristobalite, and tridymite) on the samples were determined by comparison of the relative responses, at the appropriate diffraction angles, of the scintillation detector to the copper K a-illuminated samples with the responses at the same angles to standards prepared by uniform deposition of known amounts of the pure materials on the same filter matrix.

Results of the gravimetric and X-ray diffraction analyses, which included any necessary corrections for blank determinations run in parallel with the analyses, were used to compute the "% SiO_2" (percent free silica) in each sample; the resultant figure then was used to compute the eight-hour, time-weighted average limit for exposure to the particulate matter collected in that sample. Results of the gravimetric analyses were used in conjunction with sampling data (measured flowrates and durations of sampling) to calculate concentrations of airborne particulate matter collected on the samples, expressed in milligrams of particulate matter per cubic meter of air (mg/m3).

SULFUR DIOXIDE

Short-term instantaneous sulfur dioxide concentrations were determined utilizing a colorimetric indicator tube in conjunction with a hand-held bellows pump. The concentration of sulfur dioxide is read directly (in ppm) from the graduated tube indicated by a length of stain color change. This color change results as a reaction between sulfur dioxide, disodiumtetrachloromercurate, and methyl red to produce a change from yellow to orange.

APPENDIX E

Toxicological Information

ASBESTOS

Asbestos is a generic term referring to various fibrous mineral silicates, including chrysotile (hydrated magnesium silicate), amosite (iron-magnesium silicate), crocidolite (sodium-iron silicate), tremolite (calcium-magnesium silicate), anthophyllite (another iron-magnesium silicate), and actinolite (calcium-magnesium-iron silicate).

The potential health hazard associated with exposure to asbestos results from inhalation of airborne fibers; small asbestos fibers can pass readily through the upper respiratory tract and be deposited in the terminal bronchioles of the lung. There they can produce a local irritation which the body attempts to overcome by initiating a tissue response resulting in the encapsulation of the fibers and consequent formation of "asbestos bodies". Asbestos fibers are the causative agents in cases of asbestosis, a progressive disease characterized by diffuse interstitial fibrosis and, at times, pleural changes of fibrosis and calcification. It is often evident by such clinical signs as rales and dyspnea. In its severe form, asbestosis can contribute to, and result in, death due to the inability of the body to obtain oxygen or the heart to pump blood through the scarred lungs.

Exposure to airborne asbestos fiber also has been associated with bronchogenic carcinoma (a malignancy of the interior of the lung), mesothelioma (a diffuse malignancy of the lining of the chest or abdomen), and cancer of the stomach, colon, and rectum. Cigarette smoking can enhance the incidence of bronchogenic carcinoma from this substance.

In order to protect workers from such occupational hazards, the Occupational Safety and Health Administration (OSHA) has established a limit of two fibers (longer than five micrometers) per cubic centimeter of air as an eight-hour, time weighted average (TWA) concentration limit. This OSHA standard also specifies a ceiling (peak) exposure limit of ten fibers per cubic centimeter of air. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value of five fibers (longer than five micrometers) per cubic centimeter of air. The National Institute of Occupational Safety and Health (NIOSH) has recommended a daily TWA exposure limit of 0.1 fiber per cubic centimeter of air, with a peak concentration limit of 0.5 fibers per cubic centimeter bases on a 15 minute sample period.

CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless gas generally produced by incomplete combustion of organic or carbonaceous materials. It is a serious hazard in many processes in the chemical, iron and steel, pottery, automobile, and mining industries.

Of all the gases that have poisonous effects upon man and animals, carbon monoxide is the most widely encountered. It exerts its effects by combining with the hemoglobin of the blood and interrupting the normal oxygen supply to the body tissues. Although this resultant oxygen deficiency is a reversible chemical asphyxia, nevertheless, damage done by severe asphyxia from any cause may not be reversible.

The acute effects of carbon monoxide exposures are dependent on the percentage saturation of hemoglobin with carbon monoxide, which in turn is dependent on the duration of exposure, concentration of carbon monoxide, the ambient temperature, and the health status and metabolic efficiency of the worker. The approximate relationship is shown in the following table.

Atmospheric Carbon monoxide concentration (ppm)	Half-time for accumulation (min)	Carboxy-hemoglobin concentration at equilibrium %	Principal Symptoms
50	150	7	Slight headache
100	120	12	Moderate headache and dizziness
250	120	25	Severe headache and dizziness
500	90	45	Nausea, vomiting collapse possible
1,000	60	60	Coma
10,000	5	95	Death

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established a permissible exposure limit (PEL) for an eight-hour, time-weighted average, (TWA) exposure of 50 ppm to maintain carboxyhemoglobin levels below 10%. The National Institute for Occupational Safety and Health recommends a time-weighted average exposure of 35 ppm for an eight-hour workday, with a ceiling concentration of 200 ppm. ACGIH currently lists as "tentative value" a short-term exposure limit (up to 15 minutes) of 400 ppm.

CHROMIUM AND ITS COMPOUNDS

Chromium (Cr) exists in the metallic state. It also forms compounds in which it has the oxidation number +2 (chromous), +3 (chromic) and +6 (chromate). The +2 state is very unstable. Chromic acid, along with chromates, are the most common forms found in industry and are in the +6 state.

Chromium is most highly toxic and irritating when it is hexavalent (+6) form, (usually as chromic acid or one of its derivatives). Also, the soluble chromates and dichromates, are much more chemically active than the insoluble lead chromate.

Chromates can cause ulceration of the nasal septum and dermatitis. Chromic acid mist, arising from chrome-plating tanks, is the most common industrial offender. However, serious chrome ulceration may result from inhalation of soluble chromate dusts as well. Some cases of nose injury have been noted among workers spraying zinc chromate paint.

An abnormal incidence of lung cancer has been reported in workers exposed to certain chromates in chromite ore processing.

Skin contact with chromate solutions can cause contact dermatitis, and hypersensitivity to chromium may result. Acute exposures to dust or mist may cause coughing and wheezing, headache, dyspnea, pain on deep inspiration, fever, and loss of weight.

The Occupational Safety and Health Administration (OSHA) has adopted an ANSI Z37.7 - 1971 standard, which established a ceiling concentration of 0.1 mg/m^3 (as chromic acid anhydrids) for chromic acid and chromates, to be exceeded at no time during any eight-hour period. In addition, OSHA has adopted an eight-hour, time-weighted average (TWA) concentration limits of 0.5 mg/m^3 (as Cr) for soluble chromic or chromous salts, and one mg/m^3 (as Cr) for metal or insoluble salts. The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted eight-hour, TWA threshold limit values (TLVs) of 0.05 mg/m^3 (as Cr) for chromic acid, chromates, and certain insoluble forms of chromates from chromite ore processing, and 0.5 mg/m^3 (as Cr) for soluble chromic or chromous salts. ACGIH lists chromate from chromite ore processing as a human carcinogen.

The National Institute for Occupational Safety and Health (NIOSH) has proposed and recommends two standards for chromium (+6). The first is concerned with non-carcinogenic, but otherwise hazardous materials. The second pertains to other chromium (+6) materials associated with an increased incidence of lung cancer. Based on current evidence, NIOSH indicated that "non-carcinogenic chromium (+6)" is the chromium (+6) in monochromates and bichromates (dichromates) of hydrogen, lithium, sodium, potassium, rubidium, ceasium, and ammonium, and chromiumoxide (chromic acid anhydride). Carcinogenic chromium (+6) comprises any and all chromium materials not included in the non-carcinogenic group above. The criteria recommended by NIOSH are as follows:

(1) Carcinogenic chromium (+6):

a. 0.001 mg/m^3 (as Cr)
(TWA concentration limit for an eight to ten-hour workday)

(2) Non-carcinogenic chromium (+6):

a. 0.025 mg/m^3 (as Cr)
(TWA concentration limit for up to ten-hour workday, 40-hour work week)

b. 0.05 mg/m^3 (as Cr) (acceptable ceiling concentration limit for any 15 minute period)

COAL DUST

Coal is a native, black or brownish, brittle or soft substance consisting chiefly of carbon, but also of hydrogen, nitrogen, oxygen and other elements (Si,P,As,Fe, etc.).

A commonly used term for chest disease resulting from inhalation of coal dust is coal workers' pneumoconiosis. Another frequently used term is anthrosilicosis, an appropriate description, since all coals contain not only carbon, but varying amounts of silica.

In chronic respiratory disease of coal workers, the onset is gradual, often forcing the patient to seek medical advice for the first time only after a bacterial infection or heavy exposure to dust in a mine accident. Cough, wheezing, severe dyspnea, and sputum production varies with infection and smoking habits. The sputum is usually black, and in advanced disease large amounts of thick material referred to as melanosis are produced indicating cavities caused by aseptic necrosis. Tuberculosis and bacterial pneumonia, although more manageable with modern chemotherapy, are serious complications. Pulmonary arterial circulation involvement and right heart failure are secondary to emphysema and hypoxia leading to increasing disability and death.

The Occupational Safety and Health Administration (OSHA) has established an eight-hour, time-weighted average (TWA) concentration limit of 2.4 mg/m^3 for "respirable" coal dust containing less than five percent quartz, and established the following formula as an eight-hour, TWA concentration limit for respirable coal dust containing more than five percent quartz:

$$TLV = \frac{10\ mg/m^3}{\%\ SiO_2 + 2}$$

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted an eight-hour, TWA threshold limit value of 2 mg/m^3 for respirable coal dust containing less than five percent quartz. If the coal dust contains more than five percent quartz, ACGIH also recommends the respirable mass formula established by OSHA. The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of 0.05 mg/m^3 of free silica in respirable dusts.

IRON AND ITS COMPOUNDS

Iron (Fe) is a malleable, silver-grey metal. Ferric oxide is a dense, dark red powder or lumps.

The inhalation of iron oxide fumes or dust may cause a benign pneumoconiosis (siderosis). It is probable that the inhalation of pure iron oxide does not cause fibrotic pulmonary changes, whereas the inhalation of iron oxide plus certain other substances may cause injury.

On the basis of epidemiological evidence, exposure to hematite dust increases the risk of lung cancer for workers working underground, but not for surface workers. It may be, however, that hematite dust becomes carcinogenic only in combination with radioactive material, ferric oxide, or silica. There is no evidence that hematite dust or ferric oxide causes cancer in any part of the body other than the lungs.

Iron compounds derive their dangerous properties from the radical with which the iron is associated. Iron pentacarbonyl is one of the more dangerous metal carbonyls. It is highly flammable and toxic. Symptoms of overexposure closely resemble those caused by nickel carbonyl ($Ni(CO)_4$) and consist of giddiness and headache, occasionally accompanied by fever, cyanosis and cough due to pulmonary edema. Death may occur within 4 to 11 days due to pneumonia, liver damage, vascular injury and central nervous system degeneration.

Soluble iron salts, especially ferric chloride and ferric sulfate, are cutaneous irritants and their aerosols are irritating to the respiratory tract. Iron compounds as a class are not associated with any particular industrial risk.

The Occupational Safety and Health Administration (OSHA) has established an eight-hour, time-weighted average (TWA) concentration limit of ten mg/m^3 as a standard for occupational exposure to iron oxide fume. There are no OSHA standards for other iron compounds. The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted eight-hour, TWA threshold limit values and lists as "tentative" short-term (up to 15 minutes) exposure limits (STEL) as follows:

Compound	TWA-TLV	STEL (Tentative)
Iron Oxide fume	5 mg/m^3	10 mg/m^3
Iron Pentacarbonyl	0.01 ppm (0.08 mg/m^3)	--
Iron Salts, Soluble (as Fe)	1 mg/m^3	2 mg/m^3

LEAD AND ITS INORGANIC COMPOUNDS

Lead is one of the most toxic of the common industrial metals. All but the most insoluble lead compounds (sulfide or chromate) are readily absorbed into the bloodstream via inhalation. Lead and its inorganic compounds are not ordinarily absorbed through the skin. However, this is not the case with respect to exposures to organic lead compounds which are easily absorbed through the skin. The most significant route of exposure is, therefore, contributed by inhalation of airborne lead containing materials.

The first detectable clinical evidence of overexposure to lead is an increase in the lead concentration in the urine, followed shortly by an increase in blood lead levels. Early symptoms of overexposure include gastrointestinal disorders, colic, constipation, etc. As the exposure persists or increases, blood tests show the presence of stippled cells followed, in time, by anemia. There is general body weakness leading, in some cases, to paralysis chiefly of the exterior muscles of the wrists and ankles. The most serious result of overexposure is damage to the brain (encephalopathy). This is rare in adults but common among children who have ingested lead compounds such as those in leaded paints.

The Occupational Safety and Health Administration (OSHA) standard for airborne lead in the workplace is presently 50 micrograms per cubic meter of air (50 ug/m^3). The "action level" which triggers some requirements is 30 ug/m^3.

MANGANESE AND ITS COMPOUNDS

Manganese (Mn) is a reddish-grey or silvery, soft metal. Manganese and its compounds can enter the body via inhalation of fume or dust and percutaneous absorption of liquids.

The early phase of chronic manganese poisoning is most difficult to recognize, but it is also most important to recognize since early removal from the exposure may arrest the course of the disease. The onset is insidious, with apathy, anorexia, and asthenia. Headache, hypersomnia, spasms, weakness of the legs, arthralgias, and irritability are frequently noted. Manganese psychosis follows with certain definitive features: unaccountable laughter, euphoria, impulsive acts, absentmindedness, mental confusion, aggressiveness, and hallucinations. These symptoms usually disappear with the onset of true neurological disturbances, or may resolve completely with removal from manganese exposure.

Progression of the disease presents a range of neurological manifestations that can vary widely among individuals affected. Speech disturbances are common: monotonous tone, inability to speak above a whisper, difficult articulation, incoherence, even complete muteness. The face may take on masklike quality, and handwriting may be affected by micrographia. Disturbances in gait and balance occur, and frequently propulsion, retropropulsion, and lateropropulsion are affected, with no movement for protection when falling. Tremors are frequent, particularly of the tongue, arms and legs. These will increase with intentional movements and are more frequent at night. Absolute detachment, broken by sporadic or spasmodic laughter, ensues, and as in extraphramidal affections, there may be excessive salivation and excessive sweating. At this point the disease is indistinguishable from classical Parkinson's disease.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established a ceiling concentration limit of five mg/m^3 (as Mn) for occupational exposure to manganese and its compounds. Currently, ACGIH adopted an eight-hour, time-weighted average (TWA) threshold limit value (TLV's) of 1.0 mg/m^3 (as Mn) and 0.1 mg/m^3 for manganese cyclopentadienyl tricarbonyl and manganese tetroxide, respectively. ACGIH lists as "tentative" a short-term exposure limit (up to 15 minutes) of 0.3 mg/m^3 for manganese cyclopentadienyl tricarbonyl. The values for this latter substance carry "skin" notation, warning of the potential for percutaneous absorption; these specific concentration limits are based on the presumption that there is no concurrent exposure via skin and oral ingestion routes.

MORPHOLINE

Morpholine (C_4H_8ONH) is a colorless, hygroscopic liquid with amine-like odor. It can enter the human body via inhalation of vapor or percutaneous absorption of liquid.

Morpholine vapor is an irritant of the mucous membranes. Symptoms include visual aberrations, noise irritation, cough, respiratory irritation, severe eye and skin irritation from liquid splashes, skin irritation from repeated or prolonged overexposure.

Some instances of skin and respiratory tract irritation have been observed in industry. Workers exposed to low vapor concentrations for several hours complained of foggy vision with rings around lights, the result of corneal edema which cleared within three to four hours after cessation of exposure. The liquid is a severe skin irritant. The liquid dropped in the eye of a rabbit caused moderate injury, with ulceration of the conjunctiva and corneal clouding.

The effects on animals from exposure to morpholine have been described as similar to those produced by ammonium hydroxide. Nasal and bronchial irritation, as with ammonia gas, and liver damage predominate.

To prevent irritation and harmful effects on the eyes and vision, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of 20 ppm as a standard for occupational exposure. ACGIH also lists as "tentative" a short-term exposure limit (up to 15 minutes) of 30 ppm. This standard carries the "skin" notation, warning of the potential for percutaneous absorption; the specific concentration limit is based on the presumption that there is no concurrent exposure via the skin absorption and oral ingestion routes.

NITROGEN OXIDES
(NO_x)

"Nitrogen oxides" here refers to the mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). Since nitrogen dioxide in the working environment results, at least in part, from oxidation of nitric oxide, occupational exposures are usually to mixtures of these gases rather than to either gas alone. Nitric oxide is a colorless gas which reacts with oxygen to form nitrogen dioxide at ordinary temperatures. Nitrogen dioxide is a reddish-brown gas with a characteristic odor, or (below 21.1°C) a yellow liquid.

Exposure to high concentrations of nitrogen oxides may result in severe pulmonary irritation and methemoglobinemia. The former is believed to be caused by the nitrogen dioxide portion, while the latter is mainly caused by nitric oxide. Typically, acute exposure may produce immediate malaise, cyanosis, cough, dyspnea, chills, fever, headache, nausea, and vomiting. Collapse and death may occur if exposure is sufficiently high. When lower concentrations are encountered, there may be only mild signs of bronchial irritation, followed by a five to twelve hour symptom-free period. Many fatalities occur because of the suddenness and severity of the effects and the characteristic delay in onset. If the acute episode is survived, "bronchiolitis fibrosa obliterans" (severe and increasing dyspnea with fever and cyanosis) may develop usually within a few days but may be latent for as long as six weeks.

Chronic exposure may result in pulmonary dysfunction. The most common complaint is of dyspnea upon exertion. Nitrogen dioxide is about four or five times as toxic as nitric oxide.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of 25 ppm as a standard for occupational exposures to nitric oxide and a ceiling concentration limit of five ppm, not to be exceeded at any time, for nitrogen dioxide. This ceiling limit for nitrogen dioxide was adopted on the basis of prevention of immediate injury or adverse physiologic effects from prolonged daily exposures. The National Institute for Occupational Safety and Health (NIOSH) has recommended a 40-hour work week, TWA concentration limit of 25 ppm for nitric oxide and a ceiling concentration limit (up to 15 minutes) of one ppm for nitrogen dioxide.

NOISE

The major potential health hazard associated with exposure to noise lies in the possibility of producing permanent hearing loss. Factors which play a role in deciding how much permanent hearing loss will be sustained after exposure to high noise levels include the level and frequency of the noise, the duration of exposure per day, the number of years of repeated daily exposure, and individual susceptibility (age, genetic make-up, diet, and use of autotoxic drugs are just some of the variables which determine individual susceptibility).

The other adverse effects suspected as being caused by high noise levels include physiological disturbances (high blood pressure, aural pain, nausea and impaired muscular control when exposure is severe), and an increase in the accident frequency rate resulting from interference with speech communication and the disrupting of concentration. Also, some temporary hearing loss results from daily exposure to high noise levels, reportedly because the hair cells in the inner ear become fatigued and can no longer respond as well.

The standard as set by the Occupational Safety and Health Administration (OSHA) is based on daily time-weighted average exposure limits (over an eight-hour period) which, it is thought, will protect most workers from serious hearing loss.

The elements of the OSHA standard are:

1. The acceptable level of continuous noise (amplitude peaks less than one second apart) for exposures of eight hours duration is 90 decibels (dB) as measured on the A-weighted integrating network of a Type II sound level meter set on slow response, which approximates the response of the normal human ear to sound.

2. For each additional 5 dBA above 90, the permissible exposure time is reduced by half (see Table 1 below).

TABLE 1

PERMISSIBLE NOISE EXPOSURES

Sound Level (dBA)	Duration Hours/Day
90	8
92	6
95	4
97	3
100	2
102	1½
105	1
110	½
115	¼ or less

3. No exposure to continuous noise levels in excess of 115 dBA is acceptable, regardless of duration.

4. Exposure to impulsive or impact noise (amplitude peaks greater than one second apart) in excess of 140 dB peak sound pressure level is unacceptable.

5. When workers are being overexposed on the basis of the criteria in Table 1, feasible administrative and/or engineering controls shall be utilized. If such controls fail to reduce noise exposure to within these limits, personal protective equipment shall be provided and its use strictly enforced.

6. In all cases where the noise levels exceed an equivalent noise level of 85 dBA, including noise levels from 80 to 130 dBA, a continuing effective hearing conservation program shall be administered. The allowable duration of exposure is determined by the formula:

$$\textbf{Allowable time (Hours)} = \frac{32}{2^{(L-80)/5}}$$

where L is the sound level measured on the A weighted scale (dBA).

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, as it is in most jobs in industrial settings, the combined effect shall be considered, rather than the individual effect of each. This combined effect, or total exposure, is determined by the following exposure formula.

$$\textbf{Exposure} = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$$

Where C_n is the actual time spent at sound level, n (in dBA), and T_n is the allowable time spent at sound level, n.

OSHA has defined an effective hearing conservation program, but parts of the definition have been stayed. The portions which have not been stayed are summarized below:

1. Baseline audiometric testing must be completed by August 22, 1982, and repeated annually thereafter. All audiograms must be kept for the duration of employment.

2. Audiometric tests must be given by a trained individual and the audiometer must meet the ANSI S3.6-1969 criteria. Audiometer calibrations must be done as stated in the OSHA standard.

3. Audiograms showing a significant threshold shift must be reviewed by an audiologist, otolaryngologist, or qualified physician.

4. Employees must be notified of audiogram results within 21 days of receipt of the results. Hearing protection must be worn by employees having a significant threshold shift when working in areas where noise levels exceed 85 dBA.

5. Employees exposed to an equivalent noise level of 85 dBA or greater must have annual training which includes discussions of the effects of noise on man, the use of hearing protection, and audiometric testing.

6. When employees are exposed to greater than 90 dBA a written plan to reduce noise exposures to less than an equivalent noise level of 90 dBA must be formed. The plan may include both engineering and administrative controls.

NUISANCE DUST

In contrast to fibrogenic dusts which cause scar tissue to be formed in lungs when inhaled in excessive amounts, so-called "nuisance" dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts have the following characteristics:

(1) The architecture of the air spaces remains intact.

(2) Collagen (scar tissue) is not formed to a significant extent.

(3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by rigorous skin cleansing procedures necessary for their removal. They do not appear to have a predisposing effect on tuberculosis or other infection and do not cause impaired lung function.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established time-weighed average (TWA) threshold limit values of 30 mppcf (millions of particles per cubic foot of air), based on impinger samples counted by light-field techniques or 10 mg/m^3 of total dust containing less than 1% quartz, or 5 mg/m^3 respirable dust. The Occupational Safety and Health Administration (OSHA) has established TWA standards of 50 mppcf or 15 mg/m^3 for total dust containing less than 1% quartz, or 15 mppcf or 5 mg/m^3 for respirable dust.

Quite often an industrial hygienist will use a gravimetric analysis for total dust when sampling for dusts with unknown toxicity. While the results may be compared to the nuisance dust standard for a base line reading, the dusts of unknown toxicity should in no way be considered nuisance dusts because the potential for harm has not been established.

SILICEOUS DUSTS

Free silica (SiO_2, uncombined and independent of other elements) has three crystalline forms: quartz, tridymite, and cristobalite. All three forms have similar physiologic action. The potential health hazard associated with exposure to crystalline silica is that of inhalation of the dust. Inhalation of extreme concentrations of submicron particles can lead to diffuse, fulminating lung fibrosis within a few months. However, development of the more common chronic type of silicosis usually takes many years. The effect of repeated exposure is characterized by an initial generalized linear increase in lung density progressing to small nodules scattered throughout the lung tissue. If exposure continues, these nodules increase in size to the point where they interfere with respiration. Although silicosis rarely causes death, common complications include tuberculosis, chronic bronchitis and bacterial infections.

The Occupational Safety and Health Administration (OSHA) has established the following formula as an eight-hour, time-weighted average (TWA) concentration limit, based on the quartz content of total dust:

$$TLV = \frac{30 \text{ mg/m}^3}{\% \, SiO_2 + 2}$$

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted a TWA threshold limit value (TLV) formula based on the free crystalline quartz content for total dust:

$$TLV = \frac{30 \text{ mg/m}^3}{\% \, SiO_2 + 3}$$

OSHA and ACGIH both have established a formula applicable to calculate acceptable air concentrations of the respirable fraction of total dust:

$$TLV = \frac{10 \text{ mg/m}^3}{\% \, SiO_2 + 2}$$

If the free crystalline silica content is composed primarily of tridymite and/or cristobalite, one-half the value calculated from the formula for quartz must be used.

The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of 0.05 mg/m3 of free silica in respirable dust.

ZINC AND ITS COMPOUNDS

Zinc (Zn) is a soft, silvery-white metal with a blue tinge.

The inhalation of freshly formed zinc fumes from the volatilization of zinc causes metal fume fever. A number of zinc salts may enter the body by inhalation, through the skin or by ingestion and produce intoxication. Zinc chloride has been found to cause skin ulcers, and a number of zinc compounds present fire and explosion hazards.

Symptoms of this metal-fume fever include shivering attacks, irregular fever, profuse sweating, nausea, thirst, headache, pains in the limbs and a feeling of exhaustion. Attacks are of short duration (most cases are on the way to complete recovery within 24 hours of onset of symptoms) and tolerance seems to be acquired.

The Occupational Safety and Health Administration (OSHA) has established eight-hour, time-weighted average (TWA) concentration limits of one mg/m^3 of zinc chloride fume and five mg/m^3 of zinc oxide fume. The American Conference of Governmental Industrial Hygienists (ACGIH) has established eight-hour, TWA threshold limit values (TLVs) of one mg/m^3 of zinc chloride fume, 0.05 mg/m^3 of zinc chromate (as Cr), five mg/m^3 of zinc oxide fume, and ten mg/m^3 of zinc stearate. ACGIH currently lists as "tentative" short-term (up to 15 minutes) exposure limits of two mg/m^3 of zinc chloride fume, ten mg/m^3 of zinc oxide fume, and 20 mg/m^3 of zinc stearate. The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of five mg/m^3 of zinc oxide fume for up to a ten-hour workday, 40-hour work week, with a ceiling concentration limit of 15 mg/m^3 for 15 minutes.